PERIODICAL
V. 2, no. 2 Meddel. Serie: Plankt.

LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

MEDDELELSER

FRA

KOMMISSIONEN FOR HAVUNDERSØGELSER

SERIE: PLANKTON · BIND II

NR. 2. P. JESPERSEN: INVESTIGATIONS ON THE FOOD OF THE HERRING IN DANISH WATERS

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI
1928

MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER

Serie: Fiskeri.

Bd. I, Nr. 1 C. G. Joh. Petersen: On the larval and post-larval stages of the Long Rough Dab and the Genus Pleuronectes. 2 Plates 1904. 13 p. Kr. 1.00.

» I, » 2 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. I. 12 Plates. 1905. 70 p. Kr. 5,25.

» I, » 3 Johs. Schmidt: On pelagic post-larval Halibut (Hippoglossus vulgaris Flem. and H. hippoglossoïdes Walb.) 1 Plate. 1904. 13. p. Kr. 0.75.

» I, » 4 Johs. Schmidt: De atlantiske Torskearter (Gadus-Slægtens) pelagiske Yngel i de post-larvale Stadier. Med 3 Tavler og 16 Figurer. 1905. 74 S. Kr. 3.00.

» I, » 4 Johs. Schmidt: The pelagic post-larval stages of the Atlantic Species of Gadus. A Monograph with 3 Plates and 16 Figures in the Text. 1905. 77 p. Kr. 3.00.

» I, » 5 C. G. Joh. Petersen: Larval Eels (Leptocephalus brevirostris) of the Atlantic coasts of Europe. 1905. 5 p.

» I, » 6 A. C. Johansen: Remarks on the life history of the young post-larval Eel (Anguilla vulgaris Turt.) 1904. 9 p. Kr. 0.50.

» I, » 7 Adolf Sev. Jensen: On fish-otoliths in the bottom-deposits of the Sea. I. Otoliths of the Gadus-Species deposited in the Polar Deep. 4 Fig. 1905. 14 p. Kr. 0.50.

» I, » 8 Johs. Schmidt: On the larval and post-larval stages of the Torsk (Brosmius brosme [Ascan.]) 1 Plate. 1905. 12 p. Kr. 0.75.

» II, » 1 C. G. Joh. Petersen: On the larval and post-larval stages of some Pleuronectidæ (Pleuronectes, Zeugopterus.) 1 Pl. 1906. 10 p. Kr. 0.50.

» II, » 2 Johs. Schmidt: The pelagic post-larval stages of the Atlantic species of Gadus. A monograph. Part II. 1 Pl. 1906. 20 p. Kr. 1.00.

» II, » 3 Johs. Schmidt: On the pelagic post-larval stages of the Lings (Molva molva [Linné] and Molva byrkelange [Walbaum]). With 1 Pl. and 3 Figures. 1906. 16 p. Kr. 0.75.

» II, » 4 Johs. Schmidt: On the larval and post-larval development of the Argentines (Argentina silus [Ascan.] and Argentina sphyræna [Linné]) with some Notes on Mallotus villosus [O. F. Müller]. 2 Pl. 1906. 20 p. Kr. 1.50.

» II, » 5 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. II. The marking and transplantation experiments with Plaice in the years 1903—06. 9 Pl. and 10 Figures. 1907. 122 p. Kr. 5.25.

» II, » 6 Johs. Schmidt: Marking experiments on Plaice and Cod in Icelandic waters. 2 Charts. 23 p.

» II, » 7 Johs. Schmidt: On the post-larval development of the Hake (Merluccius vulgaris Flem.) 1 Pl. 4 Figures. 1907. 10 p. Kr. 1.75.

» II, » 8 Johs. Schmidt: On the post-larval development of some North Atlantic Gadoids (Raniceps raninus [Linné] and Molva elongata [Risso]). 1 Pl. and 1 Fig. 1907. 14 p. Kr. 0.75.

» II, » 9 Johs. Schmidt: On the post-larval stages of the John Dory (Zeus Faber L.) and some other Acanthopterygian Fishes. 1 Plate. 1908. 12 p. Kr. 0.75.

» III, » 1 C. G. Joh. Petersen: On the larval and post-larval stages of some Pleuronectidæ (Zeugopterus, Arnoglossus, Solea.). 2 Plates. 1909. 18 p. Kr. 1.25.

Bd. III, Nr. 2 J. P. Jacobsen and A. C. Johansen: Remarks on the changes in specific gravity of pelagic fish eggs and the transportation of same in Danish waters. 2 Figures. 1908. 24 p. Kr. 0.75.

» III, » 3 Johs. Schmidt: Remarks on the metamorphosis and distribution of the larvae of the Eel (Anguilla vulgaris Turt.). 1 Pl. and 1 Chart. 1909. 17 p. Kr. 1.00.

» III, » 4 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. III. On the variation in frequency of young Plaice in Danish waters in 1902—07. 12 Figures. 1908. 48 p. Kr. 1.50.

» III, » 5 A. C. Johansen: Do. do. do. IV. Is the Plaice indigenous to the true Baltic? 2 Fig. 1908 23 p. Kr. 0.75.

» III, » 6 Johs. Schmidt: On the occurrence of Leptocephali (Larval Muraenoids) in the Atlantic W. of Europe. 2 Pl. & 1 Chart. 1909. 19 p. Kr. 1.50.

» III, » 7 Johs. Schmidt: On the distribution of the fresh-water Eels (Anguilla) throughout the world. I. Atlantic Ocean and adjacent regions. A bio-geographical investigation. 1 Chart. 1909. 45 p. Kr. 1.75.

» III, » 8 A. C. Johansen: Bericht über die dänischen Untersuchungen über die Schollenfischerei und den Schollenbestand in der östlichen Nordsee, dem Skagerak und dem nördlichen Kattegat. Mit 10 Figuren im Text. 1910. 142 S. Kr. 4.50.

» IV, » 1 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. V. The supposed migrations of plaice from the Kattegat and Belt Sea to the true Baltic. 5 Figures. 1912. 34 p. Kr. 1.25.

» IV, » 2 Johs. Schmidt: On the identification of Muraenoid larvae in their early (»Preleptocephaline«) stages. 1 Plate 1913. 14. p Kr. 0.75.

» IV, » 3 A. Strubberg: The metamorphosis of elvers as influenced by outward conditions. Some experiments. 1913. 11 p. Kr. 0.50.

» IV, » 4 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. VI. On the immigration of plaice to the coastal grounds and fiords on the west coast of Jutland. 1913. 26 p. Kr. 1.00.

» IV, » 5 P. L. Kramp: Report on the fish eggs and larvæ collected by the Danish research steamer »Thor« in the Langelandsbelt in 1909. With 6 Figures in the text. 1913. 39 p. Kr. 1.25.

» IV, » 6 Bjarni Sæmundsson: Continued marking experiments on plaice and cod in Icelandic waters. 7 Fig. 1913. 35 p. Kr. 1.25.

» IV, » 7 Johs. Schmidt: On the classification of the fresh-water Eels (Anguilla). 1915. 19 p. Kr. 0.75.

» IV, » 8 Ö. Winge: On the value of the rings in the scales of the Cod as a means of age determination. Illustrated by marking experiments. 1915. 21 p. Kr. 0.75.

» IV, » 9 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. VII. Marking experiments with Plaice in the North Sea off the west coast of Jutland during the years 1906—1912. With supplementary observations on the previous Danish experiments. 27 Fig. 1915. 60 p. Kr. 2.00.

» V, » 1 Johs. Schmidt: Marking experiments with Turtles in the Danish West Indies. With 5 Tables and 11 Fig. 1916. 26 p. Kr. 1.00.

MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER
SERIE: PLANKTON · BIND II · Nr. 2 · 1928

INVESTIGATIONS ON THE FOOD OF THE HERRING IN DANISH WATERS

BY

P. JESPERSEN

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI
1928

Introduction.

The researches described in the present work, on the food of the herring in Danish waters, have been carried out in accordance with resolutions passed by the International Council for the Investigation of the Sea. Several countries of northern Europe are at present working on the same question, as it is important to ascertain what herring live on in the different seas. The food of the herring, it should be noted, varies greatly in different waters; and as it also varies somewhat according to the time of year, investigations have to be carried out on a considerable scale. Extant literature gives but little and by no means detailed information as to the food of the herring in Danish waters; in the present work therefore, an endeavour has been made to procure the fullest possible data concerning the forms of nourishment chiefly sought by these fish in our home waters.

The work is based on examination of the stomach and intestine contents of a large number of herring at different stages of development. In the analyses, the various organisms have been classified as far as possible, and the numerical values of the species in question ascertained by actual count. The purpose of the investigations is to show the composition of the diet during the growth of the herring from the tiny larval stage to that of the adult fish, and, as far as the available material permits, to note variations in the nature and quantity of the food as between different waters and different seasons of the year. Various biological questions touching the method of feeding have also been dealt with. Investigations have been made for instance as to feeding in regard to the degree of maturity, and experiments carried out with a view to ascertaining at what period during the twenty-four hours the herring chiefly feed. Finally, it may be mentioned that in many cases, plankton collections have been made with a view to comparing the occurrence of different organisms in the food of the herring and in the plankton. As, however, many of the organisms which serve as food for the herring are captured only in small numbers by the plankton nets employed, comparison of this sort is only possible in the case of a few.

The aim of the present work was, first and foremost, to ascertain what organisms more especially serve as food for the herring at its various stages of development, in different waters, and at different times of year. Consequently, the material is less suitable for the consideration of particular features in the food biology of the herring. The facts noted however, afford a basis for the planning of future investigations, throwing light on various other questions in connection with the food and feeding of the herring, as to which the present material provides no information. It would be highly interesting, for instance, to investigate, throughout a series of years, in a restricted area, the fluctuations in the quantity of post-larval herring in conjunction with fluctuations in the quantity of plankton. Among other tasks may be noted: Food investigations in conjunction with race investigations; feeding during and immediately after spawning; time occupied in digestion; and investigations as to the food value of the different organisms.

The work has been carried out at the Plankton Laboratory of the Danish Commission for Fishery and Marine Investigations. I take this opportunity of expressing my sincerest thanks to the Head of that Department, Professor, Dr. C. H. Ostenfeld, for his unfailing interest in the undertaking, and for many

other marks of kindliness and confidence. At the instigation of the Director of Fisheries, F. V. Mortensen, collections of herring and plankton samples have been made frequently and regularly at different places in our waters. I am greatly indebted to cand. mag. K. Stephensen of the Zoological Museum, Copenhagen, who has kindly rendered valuable assistance in the identification of a series of amphipods, and to the Head of the Danish Biological Station, Dr. phil. A. C. Johansen, who has in various ways evinced an interest in my researches.

I. Survey of the Most Important Works Dealing with the Food Biology of the Herring.

From time to time, a great deal has been written as to the food of the herring; by far the greater part of the information given however, is very brief and lacking in detail; and is scattered about in a series of papers and larger works dealing with the herring or the herring fishery. Among works which have contributed more especially to the study of the herring and its food may be noted the following:

The earliest independent work on the food of the herring is, as far as the present writer is aware, a paper by Hans Strøm, who, in 1784, showed that the so-called "Sildeaat" or "Rødaat" consisted of crustaceans. It was not until 1866 that the next work dealing at any length with the food of the herring appeared, this being a paper by Boeck, who established three distinct types of herring food in Norwegian waters: "Rødaat" (mainly copepods), "Gulaat" (copepods and annelid larvæ) and "Svartaat" or "Krutaat" (chiefly *Limacina*)[1]). In 1873 and 1878, Möbius published two works showing that copepods constituted the principal food of the herring in the western Baltic; a similar result is arrived at by Trybom (1882 a, pp. 283—291; 1882 b, pp. 33—43) as regards the herring off the coast of Bohuslän. Sim (1883, p. 37) after examination of a great number of herring from the east coast of Scotland, showed, *inter alia*, that the composition of the food varied considerably according to the time of year, in summer consisting mainly of copepods, while in winter and spring, the principal items are young clupeoids, pelagic amphipods and *Sagitta*. In 1886, Brook and Calderwood published an important work based on a series of stomach analyses of herring from the coasts of Scotland; these writers showed, *inter alia*, that the food of herring from the east coast of Scotland differed from that of herring caught on the west. Roughly speaking, it was found that the food of the east coast herring consisted mainly of pelagic amphipods and schizopods in winter and spring, the herring of the west coast feeding at these seasons chiefly upon schizopods. In summer, and to some extent also in autumn, copepods were numerically predominant both on the west and east coasts. Two years later (1888), Th. Scott arrived at a somewhat similar result, but found that the schizopods were, also in summer, particularly in evidence in the food of the herring from the west coast of Scotland.

On the Atlantic coasts of America, Moore (1898, p. 401) found from examination of large numbers of herring in summer and autumn, that the greater part of the food consisted of copepods and schizopods. In 1902, Th. Scott (pp. 529—532) published the result of several hundred stomach analyses of herring from Scottish waters. As regards the food of the herring in Norwegian waters, interesting information is given in works by Collett (1905, pp. 25—29) and Nordgaard (1907). Copepods, cladocerans, schizopods and pteropods are noted as the most important food organisms.

In 1907, Th. Scott published the results of a further series of investigations in Scottish waters, and stated that the food of the herring there consisted mainly of the five following groups: post-larval fishes, amphipods, copepods, schizopods and decapod larvæ. Several interesting works on the food

[1]) Boeck considers that they are young specimens of the genus *Rissoa*; there can be little doubt however, but that it is the Pteropod *Limacina*, to which he refers (cf. Hardy 1924, footnote p. 23).

of larval and post-larval herring in the English Channel have been published between 1918—24 by LEBOUR (1918, pp. 457—458; 1920, pp. 277—279; 1921, pp. 459—463; 1924 a, pp. 325—330). The material examined comprised several thousand larval and post-larval herring and the result showed that herring larvæ with yolk sac live on larval gastropods, "green food" (probably diatoms and flagellates), larval bivalves, nauplii and other young stages of small crustacea, including their eggs. When the yolk sac has disappeared, they continue for a little while on a somewhat similar diet, but as their development proceeds, the post-larvæ live more and more on adult copepods.

In 1924 A. C. HARDY, published a paper "The Herring in Relation to its Animate Environment. Part I. The Food and Feeding Habits of the Herring with Special Reference to the East Coast of England". This most important work not only gives information as to the composition of the food at different stages of development of the herring, and at different times of the year, but deals also with various other questions bearing on the food biology of the herring. HARDY sums up his main results (pp. 34—35) as follows:

"Food and Feeding during Development.

1) Food is taken whilst yolk sac is still present.

2) Feeding starts with diatoms (*Coscinodiscus*), peridiniales, the ova, nauplii and young of copepods, and the protozoan *Tintinnopsis*. [Larval gastropods and bivalves are important in other areas (Lebour, Meyer).] Plant food is not taken after 12 mm. is reached.

3) From 12 to 32 mm. the post-larval herring is almost entirely dependent upon the copepod *Pseudocalanus elongatus*. From 32 mm. to metamorphosis (about 42 mm.) the copepod *Temora longicornis* may be taken as well.

4) After the metamorphosis (Whitebait stage) the range of food is greatly widened. Copepods, mysids, decapod larvæ, cypris balanus larvæ, and later young post-larval fish, form the principal food.

Food and Feeding of Adult Herring.

5) There is a rapid increase in the taking of food in spring, reaching a maximum at the end of May, followed by a gradual decrease throughout the summer to a period October to December, when feeding is almost entirely suspended.

6) The annual growth cycle and the formation of winter rings on the scales would appear to be due to the annual cycle of feeding.

7) The nature of the food gradually changes from an almost entirely non-crustaceous diet in the spring to an almost entirely crustaceous diet in the late summer.

8) The most important food organisms arranged in order of importance with their approximate proportions in the total year's food, are as follows: — *Ammodytes* 41.7 per cent., Copepods 21.0 per cent. (*Temora* 13.1 per cent., *Calanus* 6.9 per cent.), Hyperiid Amphipods 18.26 per cent., Nyctiphanid Schizopods 5.6 per cent., *Sagitta* 5.5 per cent., *Oikopleura* 3.2 per cent., *Limacina retroversa* 2.2 per cent., and fish eggs 1.3 per cent.

9) Feeding is selective and carried out by a definite act of capture.

10) The food is the same for adult herring of different ages and for both sexes.

11) The food of trawl-caught herring is the same as that of drift-caught herring, *i. e.* pelagic.

12) The quantity of catch of herring by commercial boats cannot be correlated with number feeding."

HARDY's paper gives (pp. 30—32) a fairly detailed review of the then extant literature dealing with the food biology of the herring, but as various works of interest in this connection are not mentioned there, a brief note of these is here given. Mention has already been made of works by MÖBIUS 1873, TRYBOM 1882 a, 1882 b, COLLETT 1905 and NORDGAARD 1907; a few others however, should also be noted as containing useful information. BUCH, for instance, has published, in 1883 (pp. 13—14), 1884

(pp. 92—93) and 1886 (p. 70) some investigations of the stomach contents of Norwegian spring herring, from which it appears that he found great quantities of herring roe as food. LENZ (1884, p. 174) found more especially the copepods *Temora longicornis* and *Dias longiremis* as important items in the food of the herring in the bay of Travemünde, and LILLJEBORG (1891, pp. 81—83) mentions particularly a series of copepods and cladocerans as important constituents in the food of the Baltic herring. In 1907, FISCHER stated (p. 49) that herring larvæ — in addition to copepods, *Sagitta* and young lamellibranchs — had been found in great numbers in the stomachs of herring from the North Sea. As regards the Baltic herring again, SCHNEIDER (1908, p. 80) notes various food organisms such as gammarids, mysids and isopods, and LEVANDER (1909, pp. 35—37) gives copepods and cladocerans as the principal food of the herring in the Gulf of Finland. Some observations on feeding in general are also to be found in EHRENBAUM (1912, p. 215).

Since the publication of HARDY's paper in 1924, various works have appeared dealing with questions related to the food of the herring in different waters. LEBOUR (1924 b, pp. 402—404) describes the importance of the euphausiids as food for the Channel herring, and A. SCOTT gives in the same year (pp. 31—35) the results of a series of stomach analyses of herring from the Irish Sea showing that the herring in these waters live to a very great extent on young stages of fish, *Meganyctiphanes*, crab larvæ and copepods. In 1925, several works by German writers appeared (EHRENBAUM, pp. 177—178; LISSNER, pp. 199—208; MIELCK, pp. 223—225), which contain information as to the food of the adult herring in the North Sea and Skagerrak, and that of the post-larval herring in the western waters of the North Sea. LISSNER's observations as to feeding at different times of the twenty-four hours are particularly interesting; he shows that the adult herring feed more particularly in the afternoon and evening, and cease to take nourishment about midnight or towards morning. Various information of interest will also be found in the following works published in 1925: HESSLE (pp. 27, 36 and 39—42) gives a brief survey of the composition of the food of various races of herring along the Baltic shores of Sweden; WATKIN (p. 27) writes of the food and feeding of herring in the Irish Sea; BIGELOW and WELSH (p. 103) deal with the food of the herring in the Gulf of Maine, on the east coast of the U. S. A. Finally, it may be mentioned, that HODGSON (1925, p. 25) finds a correlation between the season at which growth takes place among the herring of the southern North Sea and the time when the fish are mostly feeding. SAVAGE (1926), has investigated plankton samples from parts of the North Sea where the herring fishery is carried on, and arrives at the following result: (*l. c.*, p. 17) "The proportions of the constituent species in the plankton from the fishing ground were very similar to those given by Hardy for herring food". BIGELOW (1926, pp. 101—106), who is here for the most part summing up the results of previous investigations by other writers, mentions euphausiids and copepods as the principal food of the herring in the Gulf of Maine.[1])

With regard to the food of the herring in the inner Danish waters, information is extremely scarce, and scattered among different sources. Among such may be noted especially the following recent works: C. G. JOH. PETERSEN (1891, p. 141) found the stomachs of small herring from Holbæk Fjord filled mainly with *Mysis vulgaris*. OTTERSTRØM (1910, p. 3) mentions mysids as an important item in the food of the herring from Bornholm. BLEGVAD (1917, p. 68—70) gives a brief survey of the stomach contents of a small number of herring from the Danish waters, from which it appears that copepods were found in the majority of cases, but polychætes, gammarids, *Idothea*, mysids, cladocerans, fish, and fish eggs were also included in the food. Occasional notes of a more general character are also found here and there, but there has never been any thorough investigation, on a large scale, into the food of the herring in the Danish waters.

[1]) Since going to press OGILVIE (1927) has published a paper on the food of post-larval herring from the Scottish coasts.

II. Methods of Collecting and Treatment of the Material.

The present work is based on the examination of stomach contents — and to some extent also intestine contents — of a total of 7316 herring, of which 4489 were adults and young herring, 2827 being younger stages. Simultaneously with the collection of the herring samples, hauls were, in most cases, made on the spot with plankton nets, so as to permit of comparison between the occurrence of the respective organisms in the plankton and in the food of the herring. The plankton samples number about. 250.

The herring samples on which the investigations are based represent the following waters and localities:

Larval, post-larval and metamorphosis stages. (Length 4—50 mm).	Great Belt, Kattegat & Skagerrak, spring 1923 (young fish trawl and ring trawl)	2243	spec.
	Baltic, off coasts of Sealand, Møen and Falster, autumn 1925 (young fish trawl and ring trawl)	584	—
Adults and young herring (Length 6—30 cm).	Rudkøbing (stake net)	857	—
	The Sound and Køge Bugt (stake net and drift net)	684	—
	Samsø (stake net)	639	—
	Frederikshavn (stake net)	333	—
	Læsø Rende (otter trawl)	30	—
	Groves Flak, Kattegat (purse seine)	80	—
	North Sea, St. 2836, 2847 & 3146 (herring and young fish trawl)	60	—
	North Sea, Graadyb (young fish trawl and ring trawl)	1806	—

The position of the localities and waters where collections were made will be seen from the accompanying chart (Fig. 1, p. 8).

Collection of Material. As regards the methods employed in collecting the material, the following should be noted:

At the four localities: Rudkøbing, The Sound, Samsø and Frederikshavn, where the herring investigated were taken in stake nets, a sample was taken from the nets as nearly as possible at intervals of about. 10 days. When, on occasion, small herring were captured, a special sample of these was taken in addition to the sample of adult herring. The fish were taken from the nets when they were hauled in the morning, placed in a bag with a label, and the bag deposited in a large bucket containing 3—4 % formalin solution. As soon as the herring had been taken from the stake net, a horizontal haul was made in the immediate vicinity with a small plankton net (diameter about. 30 cm., silk No. 3). The net was towed slowly through the water for two minutes at a depth of 2 metres below the surface. The piece of silk tied at the end of the net was then removed, and, together with the accumulated material adhering to it, preserved in alcohol and labelled with various notes as to position, date, hour etc. When taking samples from the drift nets in the Sound, plankton hauls were made in the vicinity of the nets. At the close of the season the bags with the samples of herring and the plankton samples were sent in to the laboratory for examination.

In the autumn of 1922, a sample of herring from near Groves Flak, in the Kattegat, was examined, the fish having been taken in the purse seine by Swedish fishermen. This material was examined while still fresh.

A single sample of young herring was taken in Læsø Rende with the otter trawl, from the marine research vessel "Dana"; a series of hauls were made with the ring trawl, young fish trawl and herring trawl from the same vessel, in the North Sea. The two first-mentioned implements were used for a series of collections from Graadyb, off Esbjerg, during the winters of 1922—23, 1923—24, 1924—25 and 1925—26 yielding a considerable number of young herring. These were all preserved in formalin solution prior to examination.

Fig. 1. Chart showing localities where herring samples were taken.

The larval, post-larval and metamorphosis stages were collected with the young fish trawl and ring trawl from the "Dana", some in the Great Belt, Kattegat and Skagerrak (spring 1923) and some in the Baltic (autumn 1925).

Investigation of the Material. The larval, post-larval and metamorphosis stages were subjected to examination of the food throughout the whole of the alimentary canal. Larval and post-larval specimens were examined in a fresh state on board the "Dana"; the metamorphosis stages were examined after preservation in a weak solution of formalin (2—3 %). In both cases, the digestive tract was dissected out and opened with fine needles. This, like the examination itself, was done under a binocular microscope. It was often impossible to make any accurate count of the diatoms, peridinians etc., found in the food, and no quantitative investigation has therefore been made of these organisms. Also, remains of some indeterminable substance, of a pale green or brownish colour, were often found among the contents of the intestine; this mass consisted presumably of diatoms and flagellates, but it was impossible to give any numerical value for these.

All adult and young herring were, save for the sample from Groves Flak above noted, examined in a preserved state. It has been found considerably easier to analyse the stomach contents of herring fixed in formalin solution than in a fresh state. After the fish had been measured[1]) and the sex determined, the stomachs, including œsophagus and cæcum, were removed, and the contents examined in a segmented petri dish under a binocular microscope. The method of analysis consisted in identifying and counting, as nearly as possible, all the organisms present. It was often impossible to determine the species of all the organisms found in the stomach, and one had then to be content with noting the genus, or even, in some cases, resort to such terms as "unidentifiable copepods", "unidentifiable amphipods" etc. The counting was done as accurately as possible, but as the organisms were often in a state of more or less advanced decomposition, it was sometimes necessary to use an estimated figure.

As the degree of maturity in the herring influences feeding to some extent, the degree of maturity was noted in a number of cases among the adult fish. The scale of maturity generally employed (see Heincke 1898, Tabellen u. Tafeln p. VII, and Johansen 1923, p. 5 and 1924, p. 4) could not here be applied in any satisfactory manner, as the material was, in the great majority of cases, examined in a preserved state. In order to get an impression of the development of the genital organs, the maximal breadth of these was measured, in mm., with a pair of dividers. Measurements of this kind cannot of course be expected to be very accurate; the method has, however, been found sufficient to give an impression of the degree of maturity in the herring. In most cases, one could see when the herring were at the spawning stage, but it was often impossible to distinguish spents from immature fish. It was found that the breadth of the genital organs exhibited more or less parallel development in the two sexes, and the measurements for both were therefore taken together.

In dealing with the plankton samples, the usual terms for degree of frequency have been employed (rr, r, +, c, cc), as the samples collected could not be used for quantitative determinations. In places where collections were made more or less regularly (Rudkøbing, The Sound, Samsø and Frederikshavn), the depth at which the stake nets were worked was so slight that a vertical haul with the small nets used often yielded but a very small quantity of plankton indeed. It was therefore necessary to have recourse to horizontal hauls of 2 minutes' duration; and material procured in this manner is of course not suitable for quantitative investigations.

The plankton samples only afford information as to a small proportion of the organisms serving as food for the herring. Several kinds, as for instance mysids, amphipods, isopods, cumacea and polychætes are taken only in extremely small numbers with so small a plankton net as that here employed, and the samples thus give no real impression of the frequency of the organisms in question.

[1]) Larval and post-larval stages, and metamorphosis stages, were measured from point of snout to base of caudal fin; older fish from point of snout to tip of caudal fin.

Exposition of the results. The herring investigated have been divided, according to the different stages of development, into the following five groups:

1. Larval stages (yolk sac still present)	Length	4—9 mm.
2. Post-larval stages (yolk sac resorbed)	—	5—ca. 36 mm.
3. Metamorphosis stages (scale formation commenced)	—	ca. 38—50 mm.
4. Young herring	—	6—ca. 17 cm.
5. Adult herring	—	ca. 17—30 cm.

The distinction between young herring and adults is somewhat arbitrary, but as our material contained no mature fish of less than 18 cm., the limit has been taken as between 17 and 18 cm., so that the term "young herring" applies only to immature fish. The investigations at the different localities were often made at different seasons of the year, and even at one and the same locality, there is often some difference in this respect from one year to another. This lack of uniformity in the samples, due mainly to the fact that the fishery itself was carried on at different times, naturally gives rise to considerable difficulties in dealing with the material.

To give the results of individual stomach analyses would call for a disproportionate amount of space; it has been considered sufficient to show only the detailed analyses of some few samples, which are given at the end of the work (Tables I—XVIII, pp. 136—140).

In working out the results of the stomach analyses, it would have been highly desirable to find some expression for the relative value of the different organisms as food for the herring. Obviously, such organisms as copepods, mysids, fish eggs, etc. must differ very widely in respect of nutritive value. Hardy (1924, p. 19) in his investigation of the food of herring from the North Sea, takes copepods, cladocera, decapod larvæ, *Oikopleura*, *Sagitta* and *Limacina* for instance, as a unit value, and gives the larger ones, such as young specimens of *Ammodytes*, hyperiid amphipods and nyctiphanid schizopods, certain increased values, viz. 1000, 30 and 20 respectively. These relative values are based on determinations of weight; it seems, however, to the author of the present work, that calculations of this sort are based on so heterogeneous a foundation that they cannot be regarded as of any great importance. It is hardly warrantable, for instance, to take the nutritive value of a copepod as equal to that of a decapod larvæ, an *Oikopleura*, or a *Limacina*; and even among the separate groups, as for instance that of the copepods, the food value of the larger species (e. g. *Calanus*) must undoubtedly be several times that of the smaller forms (e. g. *Paracalanus* or *Acartia*). So also among other organisms such as mysids, amphipods, isopods and cumacea, the different species vary so much in size that their nutritive value must necessarily also differ to a very great extent. With the present material, which is far from uniform in itself, it would be practically impossible to fix values for the separate groups of organisms, and we have therefore not employed the method used by Hardy, but restricted our investigations to 1) the relative number of feeding herring in which the various organisms were found as part of the food, and 2) the average number per herring of the different organisms found, where the respective organisms formed part of the stomach contents.

By employing these two methods of calculation and comparing the results, we can obtain a very fair view of the occurrence of the different organisms in the food of the herring, as the first-named method gives a measure of the frequency of the different food organisms in the stomach contents, and the latter an indication of the quantity in which they are found. Calculations of this sort cannot, of course, give an exact expression of the occurrence of the organisms, but are merely intended to show, in rough outline, the importance of the organisms in question as items in the food of the herring. Calculations as to the average number of organisms per fish can of course, in view of the often considerable variation in numbers from one herring to another, only give an approximate idea as to whether the different organisms occur, on the whole, in large or small numbers in the food. In the sections dealing with

the occurrence of the different organisms in the food of the herring various tables will be found illustrating the two methods of calculation above mentioned. Tables are also given in the text, showing, by means of special symbols, the occurrence of the organisms in the plankton samples investigated, and in the stomach contents of the herring examined. We have thus three different kinds of tables, for the better understanding of which the following should be noted:

Explanation of the three different Kinds of Tables in Text.[1])

1. Tables showing the percentage of herring in which the different organisms are found as constituents of the food. The calculations are based on the total number of herring with definite stomach contents, and the two figures given in parentheses in the tables indicate respectively the number of herring containing the organisms in question, and the total number of herring containing food.
2. Tables showing the average number of organisms per herring. The calculations for the individual organisms are based on the number of specimens ascertained in the analyses, divided by the number of herring in which the organism in question was found as food. The figures in parentheses indicate respectively the total number of organisms and the number of herring in which the respective organisms were found.
3. Tables showing by special symbols the occurrence of the organisms in the plankton samples investigated and as food in the herring samples examined. The signs used for the plankton samples are: ○ species not found, ⊗ present, but scarce (rr, r), and ● common or numerous (+, c, cc). For the herring samples: ○ species not found as food in the sample investigated, and ⊕ species found as food in the sample in question.

III. Results of Investigations into the Food of the Herring in various Danish Waters.

In this chapter, a more detailed account will be given of the results of the investigations carried out in regard to the food of the herring in various Danish waters. The investigations into the food of the larval, post-larval and metamorphosis stages of herring are dealt with first, and thereafter, the food of adult and young herring.

A. Larval, Post-larval and Metamorphosis Stages of Herring.

The total material of larval, post-larval and metamorphosis stages of herring subjected to examination comprises 2827 specimens.

We shall in the following designate the earliest stages of development, in which the yolk sac is still present, as larval stages; the term post-larval being understood as embracing those stages from the resorption of the yolk sac to the metamorphosis stage (scale formation begins).

The material consists of 2243 specimens taken in spring (April-May 1923) and 584 taken in autumn (October 1925). The spring material comprises 101 larval stages and 2142 post-larval and metamorphosis stages, the autumn material including 83 larval and 501 post-larval specimens. The material from the spring of 1923 was collected at a series of stations in the Great Belt, the Kattegat and the Skagerrak, that from the autumn of 1925 being procured from the Baltic, off the coasts of Sealand, Møen

[1]) In the two first tables, the signs below are used with the meaning here given:
x No investigation.
— Investigation with negative result.

and Falster (see chart, p. 8). The collections were thus not made in the same waters at both seasons, which must be borne in mind in comparing the results.

It would, of course, have been very interesting to make special investigations as to the food of the herring in the different areas; the present material however, is not sufficiently extensive for more detailed researches, and we shall therefore restrict ourselves, in the following, to a general description of the food of the larval, post-larval and metamorphosis stages of herring in Danish waters.

1. The food of the larval stages (yolk sac still present).

The material at this stage of development comprises 101 specimens from the spring of 1923 and 83 from the autumn of 1925. The spring specimens vary, in point of total length, from 4—9 mm.; those from the autumn between 6—9 mm.[1]) The table below gives the number of larvæ examined, together with the relative quantity of these found with food in the alimentary canal.

Table 1. Showing number of larval herring examined, and relative quantity of these with food, in the spring of 1923 and autumn of 1925.

Length in mm.	Spring 1923			Autumn 1925		
	Number examined	Number feeding	Percentage feeding	Number examined	Number feeding	Percentage feeding
4	45	0	0.0	—	—	—
5	41	2	4.9	—	—	—
6	3	0	0.0	13	0	0.0
7	2	0	0.0	30	0	0.0
8	4	1	25.0	39	0	0.0
9	6	1	16.7	1	0	0.0

It will be noted that 4 of the herring larvæ from the spring have food in the digestive tract, whereas food was not found in the autumn larvæ examined. As the material from the two seasons was derived from different waters, it is possible that this may account for the difference. The four larval specimens from the spring of 1923 all had an indeterminable substance of a faint greenish colour in the alimentary canal. These investigations show, that larval herring in Danish waters can, at any rate in spring, take food before the yolk sac has disappeared. This fact has previously been noted in the case of larval herring from the Channel (Lebour 1918, pp. 457—458; 1920, p. 278; 1921, pp. 459—463) and from the North Sea (Hardy 1924, p. 5). These writers, however, found, in addition to "green food remains", also mollusc larvæ, nauplii and young stages of copepods etc. in the food of larval herring, whereas in the present material, the only food found is that coming under the heading of "green food remains".

2. The food of post-larval and metamorphosis stages.

The term post-larval is here intended to denote those stages where the yolk sac has been resorbed; in the present material, these stages range from 5 to ca. 36 mm. total length.[2]) Metamorphosis stages are those in which the first indications of scales are visible. The total length of these, in our material, varies from about 38—50 mm. It has not always been possible to distinguish with certainty between the two groups, and the limits can therefore only be given approximately. The material from the spring of 1923 comprises both groups, whereas that from the autumn of 1925 consists solely of post-larval stages from 6—16 mm.

We will first consider the food of the herring from the spring of 1923, and as we have a particularly large number of specimens in this material, they will be dealt with at some length.

In Table 2 the total length of the herring is given in mm., and for each length the following details

[1]) Among the smallest sizes of larval and post-larval stages specimens of sprat are possibly to be found.

[2]) It must be noted that possibly some of the herring shown as post-larvæ were larval stages, the yolk sacs of which were lost through damage during capture.

Table 2. Showing food in post-larval stages of herring (length 5 to about 36 mm.) and metamorphosis stages (length about 38—50 mm.). April—May 1923.

Length in mm.	Number examined	Number feeding	Percentage feeding	Phytoplankton %	Copepod nauplii %	Copepod ova %	Copepod juv. et adult %	Cladocera %	Cirripedia (Larvæ) %	Polychæta (Larvæ) %	Lamellibranch juv. %
5	27	4	14.8	100.0 (4)	—	—	—	—	—	—	—
6	18	6	33.3	100.0 (6)	—	—	—	—	—	—	—
7	12	4	33.3	25.0 (1)	75.0 (3)	—	—	—	—	—	—
8	30	12	40.0	41.7 (5)	58.3 (7)	8.3 (1)	16.7 (2)	—	—	—	—
9	61	23	37.7	43.5 (10)	56.5 (13)	—	13.0 (3)	—	—	—	—
10	109	40	36.7	25.0 (10)	50.0 (20)	5.0 (2)	12.5 (5)	—	—	—	—
11	147	43	29.3	44.2 (19)	48.8 (21)	2.3 (1)	7.0 (3)	—	—	—	—
12	224	64	28.6	23.4 (15)	42.2 (27)	7.8 (5)	21.9 (14)	—	—	—	—
13	214	59	27.6	15.3 (9)	25.4 (15)	18.6 (11)	33.9 (20)	—	—	—	—
14	160	38	23.7	5.3 (2)	23.7 (9)	10.5 (4)	52.6 (20)	—	—	—	—
15	151	34	22.5	11.8 (4)	14.7 (5)	11.8 (4)	50.0 (17)	—	—	—	—
16	147	36	24.5	2.8 (1)	13.9 (5)	22.2 (8)	58.3 (21)	—	—	—	—
17	125	33	26.4	3.0 (1)	12.1 (4)	6.1 (2)	57.6 (19)	—	—	—	—
18	65	15	23.1	—	13.3 (2)	20.0 (3)	80.0 (12)	—	—	—	—
19	32	8	25.0	—	—	12.5 (1)	62.5 (5)	—	—	—	—
20	24	12	50.0	—	—	—	83.3 (10)	—	—	—	—
21	13	7	53.8	—	—	—	71.4 (5)	—	—	—	—
22	25	15	60.0	—	—	—	66.7 (10)	—	—	—	—
23	40	27	67.5	—	—	3.7 (1)	70.4 (19)	—	—	—	—
24	66	41	62.1	—	—	—	61.0 (25)	—	—	—	—
25	78	52	66.7	—	—	5.8 (3)	65.4 (34)	—	—	—	—
26	88	66	75.0	—	—	3.0 (2)	63.6 (42)	—	—	—	—
27	52	32	61.5	—	—	6.2 (2)	62.5 (20)	—	—	—	—
28	59	49	83.1	—	—	2.0 (1)	55.1 (27)	—	—	—	—
29	29	27	93.1	—	—	11.1 (3)	63.0 (17)	—	—	—	—
30	24	21	87.5	—	—	—	66.7 (14)	—	—	—	—
31	9	7	77.8	—	—	—	71.4 (5)	—	—	—	—
32	7	6	85.7	—	—	33.3 (2)	66.7 (4)	—	—	—	—
33	5	3	60.0	—	—	—	—	—	—	—	—
34	3	2	66.7	—	—	50.0 (1)	—	—	—	—	—
35	5	4	80.0	—	—	—	—	—	—	—	—
36	3	3	100.0	—	—	33.3 (1)	66.7 (2)	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	—
38	3	2	66.7	—	—	50.0 (1)	50.0 (1)	—	—	—	—
39	1	1	100.0	—	—	—	100.0 (1)	—	—	—	—
40	6	5	83.3	—	—	—	80.0 (4)	—	—	—	—
41	7	7	100.0	—	—	—	100.0 (7)	—	—	—	—
42	10	10	100.0	—	10.0 (1)	—	100.0 (10)	—	—	10.0 (1)	—
43	11	11	100.0	—	9.1 (1)	—	100.0 (11)	9.1 (1)	—	—	9.1 (1)
44	11	11	100.0	—	18.2 (2)	9.1 (1)	100.0 (11)	—	—	27.3 (3)	—
45	19	19	100.0	—	21.1 (4)	—	100.0 (19)	31.6 (6)	5.3 (1)	15.8 (3)	10.5 (2)
46	7	7	100.0	—	—	—	100.0 (7)	14.3 (1)	14.3 (1)	14.3 (1)	—
47	7	7	100.0	—	14.3 (1)	—	100.0 (7)	14.3 (1)	14.3 (1)	14.3 (1)	28.6 (2)
48	6	6	100.0	—	33.3 (2)	16.7 (1)	100.0 (6)	50.0 (3)	—	16.7 (1)	—
49	1	1	100.0	—	—	—	100.0 (1)	—	—	100.0 (1)	—
50	1	1	100.0	—	—	—	100.0 (1)	100.0 (1)	100.0 (1)	100.0 (1)	100.0 (1)

are noted: 1) number of specimens examined, 2) number of specimens with food, 3) percentage of specimens with food, and 4) relative number of specimens in which the different groups of organisms were found as food. The absolute number of these is noted in parentheses. In a number of cases, the intestine was found to contain matter of so indeterminable a character that it could only be noted as detritus. These

specimens are included among those with food, but as this particular form of stomach contents was only found in specimens from one locality, it is presumably due to exceptional conditions, and the term "Detritus" has not therefore been given a column to itself. Under the heading of „Phytoplankton" is also included matter characterised as "green food remains", this being for the most part remains of unicellular plants.

It will be seen from the table that 14.8 % of the 5 mm. specimens examined were found to contain food. The lengths from 6—19 mm. show 22.5—40 % with food, and lengths from 20—36 mm. between 50 and 100 %. There is thus an increase in the percentage with increasing size. Among the metamorphosis stages (> 38 mm.) food was found in nearly all the specimens examined.

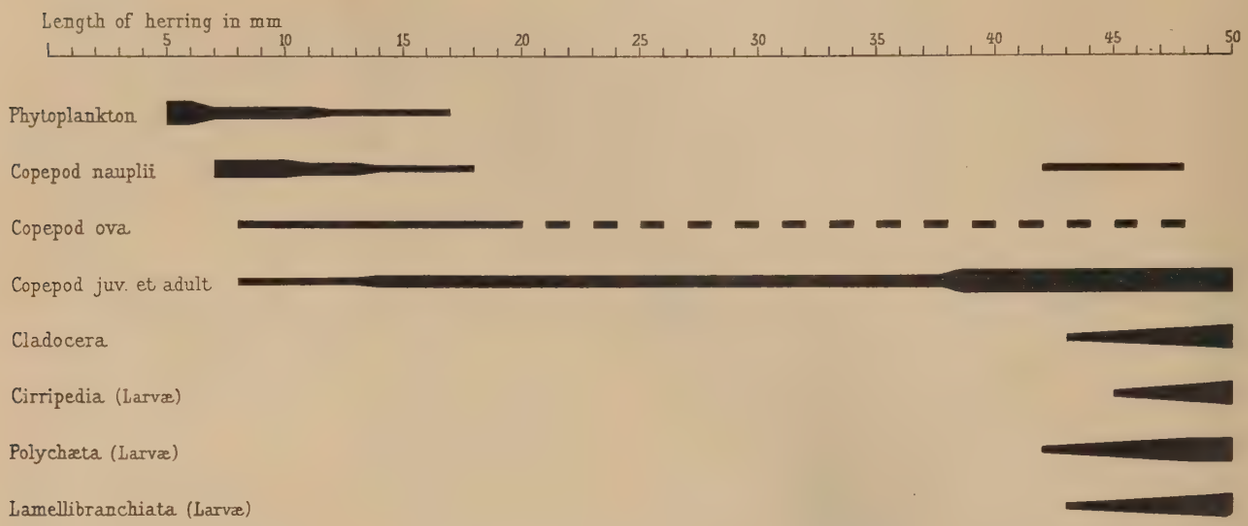


Fig. 2. Graph showing occurrence of the various organisms in food of the herring at lengths from 5—50 mm. The thickness of the lines approximately represents the relative importance of the organisms; dotted lines indicate that the organism is occasionally taken.

Phytoplankton was found as food in post-larvæ from 5—17 mm., but in relatively larger quantities among the younger stages, the percentages containing phytoplankton being 100 % for lengths from 5—6 mm., 25—50 % from 7—11 mm. and less than 25 % for sizes from 12—17 mm. Only in comparatively few cases was it possible to determine the phytoplankton found in the intestinal canal; we shall not therefore go further into the occurrence of the various organisms. The most important ones are diatoms, of which the following were found: *Paralia sulcata* (Ehr.), *Thalassiosira sp.*, *Coscinodiscus sp.*, and a single specimen of the genera *Biddulphia* and *Chætoceras*. Among peridinians, a number of specimens of the genus *Peridinium* were found, and a single *Dinophysis sp.* and one *Ceratium sp.* Nauplii of copepods have been found in the food of post-larvæ between 7 and 18 mm., and in that of metamorphosis stages from 42—48 mm. The nauplii found in the post-larvæ were predominantly those of smaller copepods (especially of *Pseudocalanus*, *Temora* and *Acartia*), whereas those found in the food of metamorphosis stages, nearly all of which are from the Skagerrak, were invariably of larger size (presumably *Calanus*). Copepod eggs were found in the food of post-larvæ from 8 mm. upwards. Among the metamorphosis stages, copepods were found in nearly all the specimens examined. Cladocera, larval stages of cirripedes, polychætes and lamellibranchs were found only in the food of metamorphosis stages (length 42—50 mm.).

The occurrence of the various organisms in the food of post-larvæ and metamorphosis stages is shown graphically in Fig. 2.

This graph has been drawn up on approximately the same principle as that employed by HARDY (1924). A comparison of this figure with HARDY's fig. 3 (*l. c.*, pp. 10—11) shows that the two agree well enough in the main, making allowance for the fact that the growth of the herring doubtless varies somewhat in the different areas from which the material was procured.

Table 3. Showing occurrence of different copepods in the food of post-larval and metamorphosis stages of herring. April—May 1923.

Length in mm.	No. of specimens containing copepods	Copepodid stages %	Pseudocal. + Paracalanus %	Acartia sp. %	Oithona sp. %	Temora longicornis %	Centropages hamatus %
5	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—
8	2	100.0 (2)	—	—	—	—	—
9	3	100.0 (3)	—	—	—	—	—
10	5	100.0 (5)	20.0 (1)	—	—	—	—
11	3	33.3 (1)	66.7 (2)	—	—	—	—
12	14	100.0 (14)	42.9 (6)	—	—	—	—
13	20	35.0 (7)	75.0 (15)	5.0 (1)	10.0 (2)	—	—
14	20	50.0 (10)	90.0 (18)	5.0 (1)	—	—	—
15	17	29.4 (5)	64.7 (11)	11.8 (2)	5.9 (1)	—	—
16	21	28.6 (6)	61.9 (13)	9.5 (2)	—	—	—
17	19	15.8 (3)	84.2 (16)	—	—	—	—
18	12	—	91.7 (11)	—	—	8.3 (1)	—
19	5	20.0 (1)	40.0 (2)	20.0 (1)	—	40.0 (2)	—
20	10	—	70.0 (7)	—	—	30.0 (3)	—
21	5	20.0 (1)	40.0 (2)	—	20.0 (1)	20.0 (1)	—
22	10	10.0 (1)	70.0 (7)	10.0 (1)	—	—	—
23	19	10.5 (2)	84.2 (16)	—	—	5.3 (1)	—
24	25	8.0 (2)	64.0 (16)	—	—	4.0 (1)	—
25	34	2.9 (1)	88.2 (30)	2.9 (1)	—	5.9 (2)	—
26	42	—	78.6 (33)	11.9 (5)	—	2.4 (1)	2.4 (1)
27	20	—	80.0 (16)	—	—	—	5.0 (1)
28	27	—	85.2 (23)	—	—	14.8 (4)	7.4 (2)
29	17	—	52.9 (9)	5.9 (1)	—	5.9 (1)	5.9 (1)
30	14	—	57.1 (8)	21.4 (3)	—	14.3 (2)	7.1 (1)
31	5	—	60.0 (3)	20.0 (1)	—	20.0 (1)	—
32	4	—	50.0 (2)	25.0 (1)	—	50.0 (2)	—
33	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—
36	2	—	100.0 (2)	50.0 (1)	—	—	—
37	—	—	—	—	—	—	—
38	1	—	100.0 (1)	100.0 (1)	—	—	—
39	1	—	100.0 (1)	—	—	100.0 (1)	—
40	4	—	50.0 (2)	—	—	75.0 (3)	—
41	7	—	28.6 (2)	—	—	100.0 (7)	14.3 (1)
42	10	—	60.0 (6)	—	—	90.0 (9)	10.0 (1)
43	11	—	36.4 (4)	9.1 (1)	18.2 (2)	100.0 (11)	45.5 (5)
44	11	—	63.6 (7)	—	18.2 (2)	81.8 (9)	27.3 (3)
45	19	—	78.9 (15)	21.1 (4)	21.1 (4)	78.9 (15)	21.1 (4)
46	7	—	57.1 (4)	—	14.3 (1)	85.7 (6)	14.3 (1)
47	7	—	57.1 (4)	14.3 (1)	28.6 (2)	85.7 (6)	42.9 (3)
48	6	—	100.0 (6)	16.7 (1)	50.0 (3)	100.0 (6)	33.3 (2)
49	1	—	100.0 (1)	—	—	100.0 (1)	—
50	1	—	100.0 (1)	—	—	100.0 (1)	—

As copepods are undoubtedly the most important organisms in the food of the growing post-larvæ and metamorphosis stages of herring, it will be interesting to examine more closely the occurrence of the different copepods in the food of these fish. The copepodid stages could rarely be determined with certainty, and are therefore taken together. A number of adult copepods were likewise unidentifiable; these, however, amount to but a very small proportion of the total.

Table 3 (p. 15) shows the number of post-larval and metamorphosis stages containing copepods, with the relative quantity and absolute number of specimens in which the respective copepods were found.

Copepodid stages of various copepods were found in the food of post-larvæ from 8—25 mm. length. The table shows that these young stages of copepods are taken as food before the fish begin to consume the adult forms. The percentage of post-larvæ containing copepodid stages decreases as the length of the post-larvæ increases; the percentage of post-larvæ containing adult copepods however, increases on the whole with increasing length of the fish. The various forms of adult copepods do not serve as food for the herring until the post-larval stages have attained a certain size. The smallest specimens found to contain adult copepods were, for instance, for *Pseudocalanus* + *Paracalanus* 10 mm., *Acartia* and *Oithona* 12 mm., *Temora* 18 mm. and *Centropages* 26 mm. In the present material, the species *Pseudocalanus* + *Paracalanus* are particularly important as food for the post-larval stages. These species also form an important item in the food of the metamorphosis stages (length about 38—50 mm.) but with the addition of *Temora longicornis* as a notable constituent.

We have a considerable number of metamorphosis stages from one particular station in the Skagerrak (St. 3000, 1/5 1923, 57°07′ N., 8°46′ E.) and it may be of interest to go further into the food of these fish. Post-larvæ are, as a rule, only found to contain a few organisms in the stomach and intestine; metamorphosis stages, on the other hand, generally contain considerable quantities. The metamorphosis stages here in question — 80 specimens, from 40—50 mm. total length — were all found to contain food in the digestive tract. Table 4 shows the percentage of herring in which the different groups of organisms were found, with the average number of the respective organisms per fish containing such.

Table 4. Occurrence of various organisms in the food of metamorphosis stages of herring at St. 3000.

	Percentage of herring containing the various organisms	Average no. of organisms per fish
Cladocera	13.7 (11)	2 (17:11)
Copepoda	100.0 (80)	33 (2659:80)
Nauplii	13.7 (11)	2 (26:11)
Cirripedia	5.0 (4)	1 (4:4)
Polychæta	15.0 (12)	1 (12:12)
Lamellibranchiata	7.5 (6)	3 (17:6)

Table 5. Occurrence of various copepods in the food of metamorphosis stages of herring at St. 3000.

	Percentage of herring containing the various copepods	Average no. of copepods per fish
Pseudocalanus + Paracalanus	63.7 (51)	9 (466:51)
Centropages hamatus	23.7 (19)	2 (41:19)
Temora longicornis	91.3 (73)	27 (1953:73)
Acartia sp.	7.5 (6)	2 (10:6)
Oithona sp.	17.5 (14)	3 (36:14)

It will be noticed that the copepods are numerically predominant. Cladocera, nauplii and polychæte larvæ appear in certain number of the fish examined, but the average number of these organisms is very small.

Closer investigation of the occurrence of the various copepods as food in these metamorphosis stages gives us the figures in Table 5.

It will be seen from this table that *Temora longicornis* is by far the most important of the copepods as an item of food for these stages (average number per fish 27). Next come *Pseudocalanus*+*Paracalanus*, with an average of 9. *Centropages hamatus* and *Oithona sp.* were found in 23.7 and 17.5 % respectively of the fish examined; the average number of specimens found in fish containing these copepods is however, only 2 and 3. The genus *Acartia* was also found only in small numbers.

Proceeding then to the consideration of the composition of the food in post-larval herring from the autumn (October 1925), we find that this differs in various respects from that of the corresponding sizes in the spring. As already mentioned however, the material representing the two seasons was collected in different waters, and comparison cannot therefore be regarded as of any great significance. The autumn material is, as mentioned, from the Baltic, off the coasts of Sealand, Møen and Falster. The table below shows the percentages of post-larvæ containing the different organisms as food.

Table 6. Showing food in post-larval stages of herring (length 6—16 mm.). October 1925.

Length in mm.	Number examined	Number feeding	Percentage feeding	Phyto-plankton %	Copepod nauplii %	Copepod juv. et adult %	Cladocera %	Lamelli-branch juv. %
6.....	6	0	0.0	—	—	—	—	—
7.....	33	2	6.1	50.0 (1)	50.0 (1)	—	—	—
8.....	114	13	11.4	46.2 (6)	30.8 (4)	23.1 (3)	—	—
9.....	104	12	11.5	58.3 (7)	16.7 (2)	25.0 (3)	—	—
10.....	67	16	23.9	18.7 (3)	25.0 (4)	56.2 (9)	6.2 (1)	6.2 (1)
11.....	49	13	26.5	23.1 (3)	23.1 (3)	53.8 (7)	—	—
12.....	51	14	27.5	28.6 (4)	7.1 (1)	64.3 (9)	7.1 (1)	7.1 (1)
13.....	28	11	39.3	27.3 (3)	18.2 (2)	54.5 (6)	—	—
14.....	17	4	23.5	—	50.0 (2)	50.0 (2)	—	—
15.....	20	7	35.0	—	14.3 (1)	85.7 (6)	—	14.3 (1)
16.....	12	4	33.3	—	—	100.0 (4)	—	—

Phytoplankton was found in the food of post-larvæ from 7—13 mm. The peridinians were here relatively more important than in the spring material. Nauplii were found in specimens from 7—15 mm., copepodid stages in fish from 8—16 mm., adult copepods however, only in specimens of 10—16 mm. The youngest post-larval herring in which the various adult copepods were found were as follows: Length 10 mm. *Pseudocalanus* + *Paracalanus*, 12 mm. *Acartia sp.*, and 15 mm. *Eurytemora hirundo*. The only cladoceran found in the food was *Bosmina maritima*. Finally, it is worth noting that in the autumn material, larval stages of lamellibranchs were found in the food of post-larvæ right down to 10 mm. length, whereas in the spring material, they were only found in the metamorphosis stages.

3. Concluding remarks on the food of larval, post-larval and metamorphosis stages of herring.

The present investigation shows that food is sometimes found in the alimentary canal of herring while the yolk sac is still preserved. The food consisted in all cases of unidentifiable matter, with a slight greenish tinge. In the post-larval stages (length 5—ca. 36 mm.), food was present only to a very slight extent in the youngest specimens (5 mm.); the lengths from 6—19 mm. showed 22—40 % and those from 20—36 mm. between 50 and 100 % with food. In the youngest specimens, the food consisted more especially of phytoplankton, with eggs, nauplii, and juvenile stages of copepods. At a length of ca. 10 mm., adult copepods began to appear as an item in the diet, and predominated to a very high

degree in the food of the older post-larvæ. Metamorphosis stages of herring (length about 38—50 mm.) also live mainly on adult copepods, but cladocerans, larval cirripedes, polychætes and lamellibranchs were also consumed in considerable numbers.

B. Adult Herring and Young Herring.

Samples of adult herring and young herring were collected at the following localities, and subjected to stomach analysis:

1. Rudkøbing.
2. The Sound and Køge Bugt.
3. Samsø.
4. Frederikshavn and Læsø Rende.
5. Groves Flak, Kattegat.
6. The North Sea, stations along the west coast of Jutland.
7. The North Sea, Graadyb.

1. Rudkøbing.

a) Material.

The present material was taken in stake nets (depth 6—9 metres) in Pæregaardsbugt on the western side of Langeland, about 7 km. north of Rudkøbing (see chart, p. 8). Plankton hauls were made at the same time as the herring samples were taken. The Rudkøbing collections cover the period from September 1923 to April 1926, but for various reasons, samples were not taken regularly. In winter, the fishery is very uncertain, and ice in particular constitutes an obstruction. In the winter of 1923—24, for instance, no samples were taken in January, February or March, and in that of 1924—25, none in January or February. In the autumn of 1925, the fishery ceased, owing to the paucity of the yield, as early as October; samples were however, procured in January, February and April 1926. The fishery is at its height in spring and autumn, summer being often a slack season. The table below shows the numbers of herring investigated in the different months.

Table 7. Numbers of herring examined per month. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923	—	—	—	—	—	—	—	—	45	42	54	28
1924	—	—	—	38	44	36	41	17	38	45	41	14
1925	—	—	31	46	61	29	17	5	35	24	—	—
1926	53	58	—	15	—	—	—	—	—	—	—	—
Total	53	58	31	99	105	65	58	22	118	111	95	42

The total number of specimens examined is 857. Table 8 shows the total lengths of the herring in the different months. Fish of less than 18 cm. total length are relatively few in number; they have been disregarded in the following, save where otherwise stated, and only fish of 18 cm. and over taken into consideration, these being designated as "adult herring".

In the Rudkøbing water, both spring- and autumn-spawning herring are found. As the degree of maturity counts for something in the feeding, this was recorded in each case at the same time as the stomach analysis was made. The method of determination has already been referred to (p. 9). The breadth of the genital organs in the adult herring examined is noted in mm. in Table 9, together with the number of specimens.

It will be seen from Table 9 that in January and February, nearly all the fish taken have their genital organs but slightly developed. In March, April and May, there are two distinct groups, viz. fish with genital organs less than 10 mm. broad and those over 15 mm. In June, July and August, the

Table 8. Length and number of herring examined. Rudkøbing.

cm.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
9	..	..	..	..	..	..	..	..	1	..	..	..	1
10	1	..	..	..	..	..	..	..	4	..	..	..	5
11	1	..	..	..	..	1	..	..	5	..	..	..	7
12	1	1	..	1	..	2	..	..	..	..	..	..	5
13	6	..	..	2	1	3	..	..	..	..	..	..	12
14	4	1	..	2	..	4	..	..	..	..	..	..	11
15	..	..	1	2	4	4	1	1	..	..	..	..	13
16	2	..	..	1	5	1	..	1	2	..	1	..	13
17	5	2	..	3	1	..	..	..	2	1	..	..	14
18	13	10	..	4	..	..	..	..	3	11	8	..	49
19	7	24	2	7	2	6	1	1	7	22	14	3	96
20	4	13	1	9	10	4	11	1	16	11	20	6	106
21	2	4	4	12	10	8	15	3	24	20	18	12	132
22	4	1	4	13	12	8	17	5	18	13	21	13	129
23	1	2	7	14	30	14	7	2	23	17	8	5	130
24	1	..	6	14	14	5	2	7	8	10	3	3	73
25	1	..	5	11	11	3	2	1	2	3	2	..	41
26	..	..	1	3	2	1	2	..	3	1	..	..	13
27	..	..	..	1	2	..	..	..	..	2	..	..	5
28	..	..	..	..	1	1	..	..	..	..	..	..	2

Table 9. Maximal breadth of genital organs in herring from different months. (Fish over 18 cm. total length). Rudkøbing.

Breadth in mm.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2	2	3	..	..	2	3	13	6	6	4	12	1
3	5	13	1	4	2	2	8	4	5	3	11	3
4	10	15	6	3	2	..	5	..	2	6	28	7
5	4	13	5	10	4	3	2	3	1	9	15	17
6	5	5	2	12	4	4	1	1	1	6	8	1
7	3	..	4	12	1	5	3	..	..	2	4	2
8	..	..	..	3	1	3	6	..	..	1	3	1
9	..	1	..	2	1	2	3	..	2	2	2	.
10	1	1	..	2	..	3	3	1	2	1	1	.
11	..	3	3	..	1	3	..	..	1	1	1	..
12	..	..	..	..	2	1	1	..	..	5	3	4
13	..	..	..	..	4	2	2	..	1	3	1	..
14	..	..	1	..	3	4	1	..	1	6	1	..
15	..	..	..	2	10	2	..	..	6	7	..	1
16	..	..	..	3	10	1	1	..	7	9	..	..
17	2	..	..	2	8	1	2	..	10	4	..	..
18	1	..	..	5	5	..	1	1	14	5	2	2
19	..	..	2	8	10	4	2	1	13	5	1	..
20	..	..	..	7	8	2	..	1	14	12	1	1
21	..	..	2	6	9	..	..	2	4	4	..	2
22	..	..	2	4	4	3	2	..	6	11	..	..
23	..	..	..	1	1	1	1	..	7	2	..	.
24	..	..	1	2	2	..	..	1	2	..	1	
25	..	..	1	..	..	1	..	..	..	1	..	.
26	..	..	..	..	..	..	..	1	..	..	..	.
27	..	..	..	1	1	..	..	..	1	..	.	..

position is somewhat obscure, but in September and October we again find two distinctly separate groups. In November and December, most of the herring have their genital organs but little developed, and we find much the same state of things as in January—February. The two maxima for mature fish in March—May and Sept.—Oct. indicate the spawning seasons of the spring-spawning and autumn-spawning herring respectively.

b. The relative numbers of herring containing food in the different months.

On examining the stomach contents of herring, it is often found that a considerable number of specimens contain no food at all. The percentage of herring containing food for the months covered by these investigations (Table 10) shows that there is no pronounced variation in the relative numbers for the different months.

Table 10. Monthly percentages of herring containing food. Rudkøbing.
(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined).

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	26.7 (12 : 45)	19.0 (8 : 42)	55.6 (30 : 54)	100.0 (28 : 28)
1924	x	x	x	59.4 (19 : 32)	78.0 (32 : 41)	77.3 (17 : 22)	67.5 (27 : 40)	82.4 (14 : 17)	36.8 (14 : 38)	35.6 (16 : 45)	43.9 (18 : 41)	42.9 (6 : 14)
1925	x	x	23.3 (7 : 30)	68.3 (28 : 41)	67.9 (36 : 53)	57.7 (15 : 26)	11.8 (2 : 17)	60.0 (3 : 5)	40.0 (10 : 25)	25.0 (6 : 24)	x	x
1926	24.2 (8 : 33)	68.5 (37 : 54)	x	53.3 (8 : 15)	x	x	x	x	x	x	x	x

Hardy on the other hand (1924, p. 15) has shown that the herring from the east coast of England feed to a very great extent in spring and summer. Hardy's figures, with those here noted from Rudkøbing given as monthly averages, are noted for purposes of comparison in the following table.

Table 11. Mean monthly percentages of herring with food from the western North Sea and from the Rudkøbing water.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Western North Sea. Mean 1922—23 (after Hardy 1924)	—	—	12.8	39.2	59.8	49.2	39.4	25.0	10.9	1.9	1.5	1.2
Rudkøbing. Mean 1923—26	24.2	68.5	23.3	60.3	72.9	67.5	39.6	71.2	34.5	26.5	49.7	71.4

It will be observed that the percentage of herring containing food in all months is considerably higher in the Rudkøbing fish than in those from the North Sea; but the Rudkøbing material does not indicate any particular season at which feeding is at its height. In January and March, relatively few were found to contain food. In Sept. and Oct. likewise, the number with positive stomach contents was relatively small, which must be taken in correlation with the fact that in these months, an essential percentage of the herring investigated were mature. It is a general rule that mature herring have less in their stomachs than immature fish, but this does not apply unreservedly to the Rudkøbing fish, as considerable quantities of food have several times been found in the stomachs of full and spawning herring. It is very interesting to note, however, that the number of mature herring containing food is relatively much greater in spring than in autumn.

The table below shows the percentages of herring with food, together with degree of maturity, in the spring material (March—May) and autumn material (Sept.—Oct.) respectively, the maximal breadths of genital organs being noted in 5 different groups.

Table 12. Percentages of herring with food, in spring and autumn, in relation to degree of maturity. Rudkøbing.

(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined).

Maximal breadth of genital organs.	March—May incl.			Sept.—Oct. incl.			
	1924	1925	Total	1923	1924	1925	Total
2— 4 mm.	66.7 (6:9)	40.0 (8:20)	48.8	26.7 (4:15)	72.7 (8:11)	100.0 (1:1)	48.1
5— 9 —	88.9 (8:9)	65.6 (21:32)	70.7	33.3 (5:15)	100.0 (7:7)	0 (0:2)	50.0
10—14 —	25.0 (1:4)	58.3 (7:12)	50.0	14.3 (1:7)	42.9 (3:7)	57.1 (4:7)	38.1
15—19 —	57.6 (19:33)	71.0 (22:31)	64.1	21.6 (8:37)	28.6 (6:21)	19.0 (4:21)	22.8
> 20 —	85.0 (17:20)	46.7 (14:30)	62.0	16.7 (2:12)	16.7 (6:36)	33.3 (5:15)	20.6

Of the herring with genital organs over 20 mm. and 15—19 mm. broad, 62 and 64.1 % respectively had food in spring; the corresponding figures for autumn are 20.6 and 22.8 %, showing that the spring-spawning herring in this water feed to a far greater extent than do the autumn-spawning fish.

c. Brief survey of the composition of the food.

We shall in this chapter endeavour to give, from the analyses of stomach contents in herring from Rudkøbing, a general survey of the composition of the food, considering first the proportion between crustaceous and non-crustaceous elements, and then the proportions in which the various groups of organisms, copepods, mysids, etc. appear in the diet. In order to obtain a larger amount of material, the samples from the respective months are taken together, so that we are considering all herring taken in the same month as a single sample.

Table 13 shows the number of herring with food examined in the different months, with the absolute and relative numbers of fish with crustaceous and non-crustaceous food respectively.

Table 13. Monthly percentages of herring containing crustaceous and non-crustaceous food. Rudkøbing.

	1923				1924									1925								1926			
	Sept.	Oct.	Nov.	Dec.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Jan.	Feb.	Mar.	April
No. of feeding herring	12	8	30	28	19	32	17	27	14	14	16	18	6	7	28	36	15	2	3	10	6	8	37	x	8
Crustaceous food No.	12	8	29	28	19	29	16	23	10	12	12	18	6	6	24	35	14	2	3	10	6	8	36	x	5
Crustaceous food %	100.0	100.0	96.7	100.0	100.0	90.6	94.1	85.2	71.4	85.7	75.0	100.0	100.0	85.7	85.7	97.2	93.3	100.0	100.0	100.0	100.0	100.0	97.3	x	62.5
Non-crustaceous food No.	0	0	3	1	5	11	10	9	9	5	7	2	0	2	6	8	4	0	1	4	2	3	3	x	3
Non-crustaceous food %	0	0	10.0	3.6	26.3	34.4	58.8	33.3	64.3	35.7	43.7	11.1	0	28.6	21.4	22.2	26.7	0	33.3	40.0	33.3	37.5	8.1	x	37.5

It is very distinctly apparent that the crustacea play by far the chief part in the food of the herring, other organisms being as a rule of minor importance.

Calculating the average monthly percentage of herring with crustaceous and non-crustaceous food, we obtain the figures shown in Table 14, p. 22.

The calculations show that crustaceous food was found in 82.7—100 %, non-crustaceous in 1.8—48.8 % of the feeding herring examined in the different months. The mean value for herring with crustaceous food is 93.1 % and for those with non-crustaceous food 25.2 %.

As the organisms found in the food of the herring belong to many different species, and these vary greatly in size, it is impossible, by direct comparison between the numbers of the various organisms,

Table 14. Mean monthly percentages of herring with crustaceous and non-crustaceous food. Rudkøbing, 1923—26.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Crustaceous food	100.0	97.3	85.7	82.7	93.9	93.7	92.6	85.7	95.2	91.7	98.3	100.0
Non-crustaceous food	37.5	8.1	28.6	28.4	28.3	42.7	16.6	48.8	25.2	25.7	10.5	1.8

to obtain any exact indication of the importance of individual species as food for the herring. We shall therefore confine ourselves to an examination of the relative frequency with which the different groups of organisms, such as copepods, cladocerans, mysids etc., appear in the food.

A more detailed account of the occurrence of the various species in the food will be found in the next chapter. Some idea as to the relative frequency of the different groups of organisms in the food may be obtained by calculating, from the total number of feeding herring for each month, the percentage of fish in which the respective organisms are found.

The monthly percentages are given in Table 15 and the values found for the more important organisms are shown graphically in Fig. 3 (p. 23).

Table 15. Monthly percentages of herring containing the various groups of organisms, calculated from the total number of feeding herring in the respective months. Rudkøbing.

	1923				1924									1925								1926		
	Sept.	Oct.	Nov.	Dec.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Jan.	Feb.	April
Copepoda	75.0	75.0	20.0	42.9	94.7	90.6	94.1	66.7	28.6	57.1	50.0	27.8	16.7	42.9	85.7	83.3	46.7	—	66.7	50.0	100.0	100.0	97.3	62.5
Cladocera	—	25.0	—	—	—	21.9	52.9	7.4	7.1	21.4	6.2	—	—	—	10.7	50.0	80.0	50.0	—	60.0	—	—	—	—
Mysidacea	25.0	—	33.3	78.6	5.3	3.1	11.8	29.6	7.1	21.4	18.7	61.1	16.7	14.3	3.6	5.6	20.0	50.0	33.3	—	16.7	—	2.7	—
Amphipoda	25.0	—	76.7	75.0	5.3	—	5.9	22.2	21.4	35.7	6.2	33.3	66.7	—	—	—	—	—	33.3	—	—	—	2.7	—
Isopoda	—	12.5	20.0	3.6	—	—	—	18.5	14.3	14.3	18.7	38.9	16.7	28.6	—	—	—	50.0	33.3	10.0	—	—	—	—
Cirripedia	—	—	—	3.6	31.6	15.6	5.9	—	—	—	—	11.1	—	—	10.7	—	—	—	—	—	16.7	—	5.4	37.5
Decapoda	8.3	—	3.3	3.6	—	3.1	5.9	3.7	7.1	14.3	—	—	—	—	—	2.8	20.0	—	33.3	—	—	—	—	
Cumacea	—	—	—	—	—	—	—	3.7	7.1	7.1	6.2	16.7	—	—	—	2.8	—	—	33.3	—	—	—	—	—
Polychæta	—	—	3.3	—	—	25.0	—	7.4	35.7	7.1	—	—	—	14.3	17.9	13.9	—	—	—	—	—	—	—	—
Gastropoda	—	—	—	—	—	—	—	7.4	—	7.1	—	5.6	—	—	—	—	13.3	—	—	—	—	—	—	—
Chætognatha	—	—	—	—	—	—	—	—	14.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Appendiculariæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16.7	—	—	—
Pisces	—	—	—	3.6	—	—	11.8	18.5	28.6	21.4	6.2	5.6	—	—	—	—	6.7	—	33.3	—	—	—	—	—
Pisces ova	—	—	3.3	—	26.3	12.5	52.9	7.4	—	7.1	37.5	—	—	14.3	3.6	8.3	6.7	—	—	10.0	16.7	37.5	8.1	37.5

The graph shows that the relative frequency of the individual organisms varies considerably for the same months in different years; in the case of the most important organisms however, there is in the main a relatively nice agreement. Table 16, p. 24 shows the monthly mean values calculated from the available material.

These calculations show that the group of organisms found throughout all months of the year — excepting November and December — in the greatest number of feeding herring, is that of the copepods. Cladocerans appear in the food only during the period from April to October. Mysids and amphipods are, in the main, much alike in their occurrence: they appear in the food more especially during the latter half of the year, and both are found in a remarkably large number of specimens in November and December. Both isopods and cumacea likewise appear to serve as food, more especially in the latter half of the year. Cirripede larvæ are of but very slight importance in this connection, but are noted in the food for several months in the year. Decapod larvæ are restricted to the period from May to November.

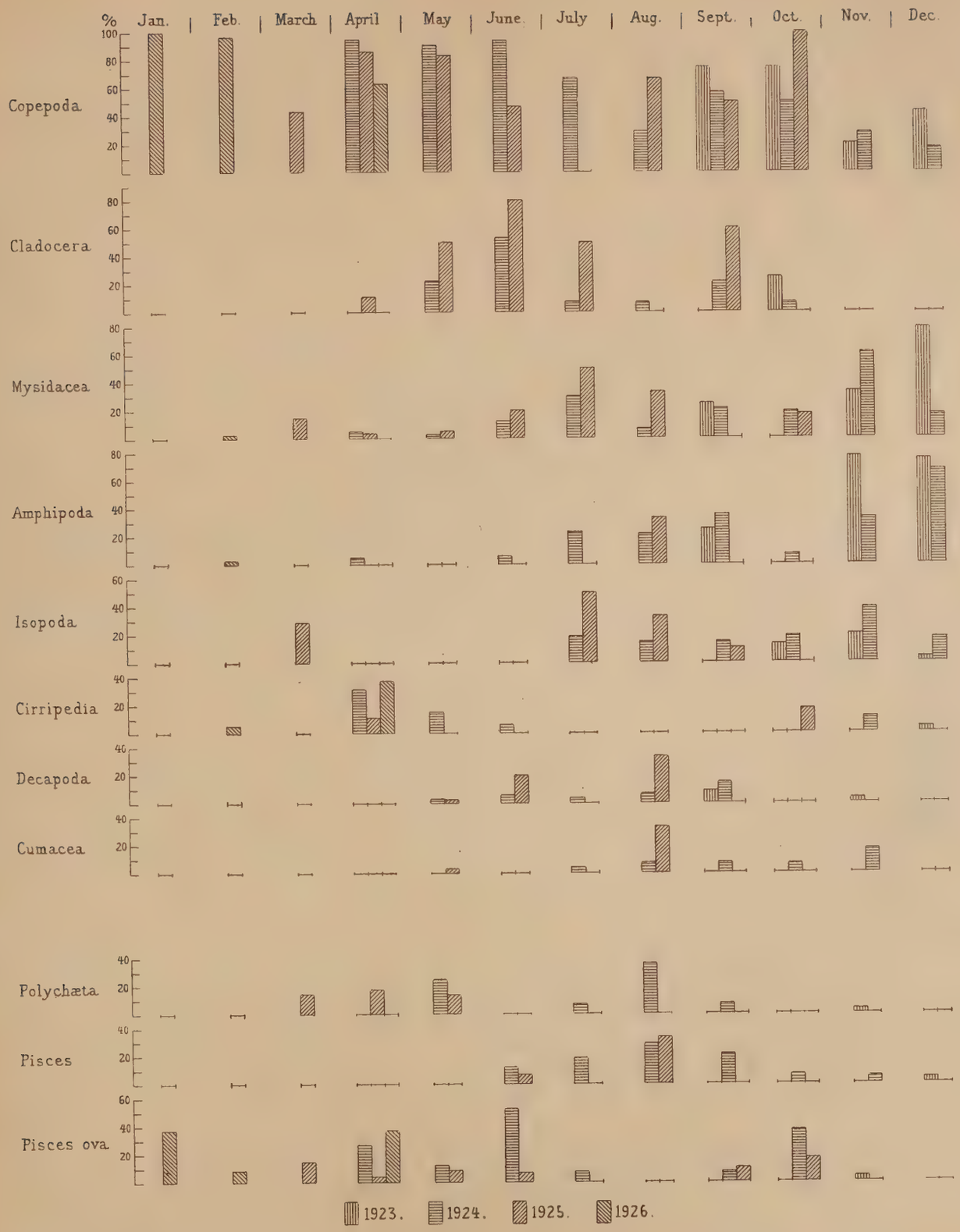


Fig. 3. Monthly percentages of herring stomachs containing the more important groups of organisms. Rudkøbing.

Table 16. Mean monthly percentages of herring containing the different groups of organisms. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Copepoda	100.0	97.3	42.9	81.0	86.9	70.4	33.3	47.6	60.7	75.0	23.9	29.8
Cladocera	—	—	—	3.6	35.9	66.4	28.7	3.5	27.1	10.4	—	—
Mysidacea	—	2.7	14.3	3.0	4.3	15.9	39.3	20.2	15.5	11.8	47.2	47.6
Amphipoda	—	2.7	—	1.8	—	2.9	11.1	27.3	20.2	2.1	55.0	70.3
Isopoda	—	—	28.6	—	—	—	34.2	23.8	8.1	10.4	29.4	10.1
Cirripedia	—	5.4	—	26.6	7.8	2.9	—	—	—	5.6	5.5	1.3
Decapoda	—	—	—	—	2.9	12.9	1.8	20.2	7.5	—	1.6	1.8
Cumacea	—	—	—	—	1.4	—	1.8	20.2	2.4	2.1	8.3	—
Polychæta	—	—	14.3	6.0	19.4	—	3.7	17.8	2.4	—	1.6	—
Gastropoda	—	—	—	—	—	6.6	3.7	—	2.4	—	2.8	—
Chætognatha	—	—	—	—	—	—	—	7.1	—	—		
Appendiculariæ	—	—	—	—	—	—	—	—	—	5.6	—	—
Pisces	—	—	—	—	—	9.2	9.2	30.9	7.1	2.1	2.8	1.8
Pisces ova	37.5	8.1	14.3	22.5	10.4	29.8	3.7	—	5.7	18.1	1.6	—

Polychætes seem to serve as food for the herring chiefly during the period from March to August. Gastropods, chætognaths and appendicularians are only found in a small number of specimens, and chiefly during the latter half of the year. Fish appear as herring food in a number of cases, but these are restricted to the period from June to December. Fish eggs are found in the food in nearly every month of the year, but the percentage of herring with fish eggs in the stomach contents varies very greatly for the different months.

Further illustration of the great difference in the composition of herring food at different seasons will be found in Tables I—IV (p. 136) which give a detailed survey of the stomach analyses of some samples from April—May and Nov.—Dec. These show most distinctly that in spring, the stomach contents consist almost exclusively of copepods, whereas during the last few months of the year, mysids and amphipods are far more in evidence.

d. Systematic survey of the occurrence of the different organisms in the food.

In this chapter, we shall proceed to a closer consideration of the occurrence of the individual species as items in the food of the herring from Rudkøbing. The crustacea are taken first, thereafter the various groups of non-crustaceous organisms found in the food. Save where otherwise mentioned, the various data refer only to adult herring (over 18 cm. length). For explanation of the different figures in the tables, and the symbols employed to denote occurrence of the different organisms in plankton and herring samples, see p. 11.

Cladocera.

Cladocerans were found in summer in the stomach contents of a considerable number of the herring examined. They appear in the food only during the period from April to October.

Table 17. Monthly percentages of herring containing cladocerans. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	25.0 (2:8)	—	—
1924	x	x	x	—	21.9 (7:32)	52.9 (9:17)	7.4 (2:27)	7.1 (1:14)	21.4 (3:14)	6.2 (1:16)	—	—
1925	x	x	—	10.7 (3:28)	50.0 (18:36)	80.0 (12:15)	50.0 (1:2)	—	60.0 (6:10)	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

As regards numerical value, cladocerans never appear in the food in any great quantity. The greatest number found in a single stomach is 30 ($^{14}/_{4}$ 25). The average number of cladocerans per fish will be seen from the Table 18.

Table 18. Average number of cladocerans, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	2 (5 : 2)	—	—
1924	x	x	x	—	1 (8 : 7)	5 (46 : 9)	1 (2 : 2)	1 (1 : 1)	10 (31 : 3)	1 (1 : 1)	—	—
1925	x	x	—	14 (41 : 3)	4 (65 : 18)	3 (33 : 12)	1 (1 : 1)	—	3 (19 : 6)	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

A small number of young herring from June 1924 and September 1925 show that they feed on cladocerans to a greater extent than do the adult fish. The material comprised 8 (length 11—15 cm.) and 7 (length 9—11 cm.) specimens, containing cladocerans, and the average number of cladocerans per fish was 12 and 11 respectively, the average for adult herring in the months in question being 5 and 3 respectively.

The following species of cladocera have been found in the food of herring from Rudkøbing:

Evadne Nordmanni Lovén
Evadne spinifera P. E. Müller
Podon intermedius Lillj.

The two species *Podon Leuckarti* G. O. Sars and *Podon polyphemoides* (Leuck.) which have occasionally been met with in the plankton samples, have not been identified with certainty in the stomach contents.

Owing to the poor state of preservation in which cladocerans appear in the stomachs of the herring, it is often difficult to determine the species with certainty, and in the following survey therefore, only the occurrence of the genera *Evadne* and *Podon* is shown.

Evadne sp. The genus *Evadne* appears in the food of the herring from May to October.

Table 19. Monthly percentages of herring containing Evadne. Rudkøbing.

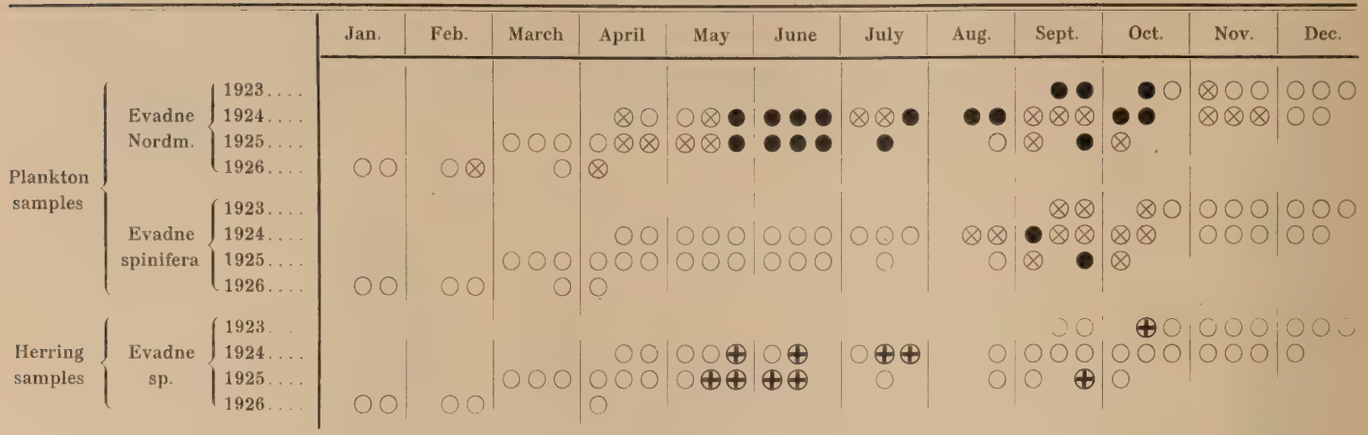
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	25.0 (2 : 8)	—	—
1924	x	x	x	—	3.1 (1 : 32)	29.4 (5 : 17)	7.4 (2 : 27)	—	—	—	–	
1925	x	x	—	—	36.1 (13 : 36)	73.3 (11 : 15)	—	–	60.0 (6 : 10)	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

During the summer months, *Evadne* was found in the food of a relatively large number of herring, but as a rule only a few specimens in each. The highest monthly average for the number of *Evadne* per herring is 5, and the greatest number found in any single stomach only 16 ($^{18}/_{6}$ 24).

In summer, both *Evadne Nordmanni* and *Evadne spinifera* are common in the plankton samples from Rudkøbing, *E. Nordmanni* being however, as a rule the more numerous. Table 20 shows the occurrence of the two species in the plankton samples, and also the samples of herring where *Evadne* was found in the food (explanation of symbols see p. 11).

E. Nordmanni is found in the plankton samples from all months of the year excepting December, January and March, and has been noted as common from the end of May to mid-October; *E. spinifera* on the other hand is a pronounced autumn form. *Evadne* appears in the food of the herring chiefly during the period May—July, and there can thus be little doubt that it is *E. Nordmanni* which is of the greater importance of the two as food for the herring.

Table 20. Occurrence of Evadne Nordmanni and Evadne spinifera in plankton samples, and of the genus Evadne in herring samples. Rudkøbing.



Podon sp. The percentage of herring containing *Podon* is, as will be seen from Table 21, highest in the months from May to July inclusive. In one year, however, (1924) there is quite a high percentage in September.

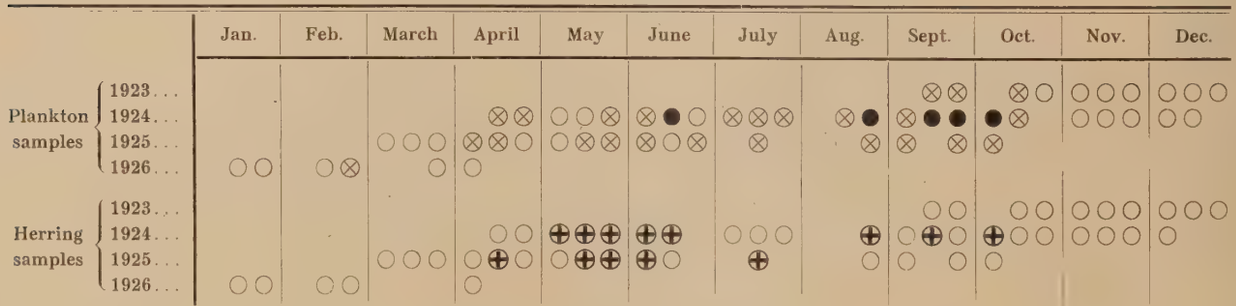
Table 21. Monthly percentages of herring containing Podon. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923.....	x	x	x	x	x	x	x	x	—	—	—	—
1924.....	x	x	x	—	18.7 (6 : 32)	47.1 (8 : 17)	—	7.1 (1 : 14)	21.4 (3 : 14)	6.2 (1 : 16)	—	—
1925.....	x	x	—	10.7 (3 : 28)	19.4 (7 : 36)	13.3 (2 : 15)	50.0 (1 : 2)	—	—	—	x	x
1926.....	—	—	x	—	x	x	x	x	x	x	x	x

The genus *Podon* has been found in some few of the herring in considerably quantities. The greatest number was 30 ($^{14}/_{4}$ 25). The monthly average per fish varied from 1 to 14.

In the plankton samples, *Podon Leuckarti* and *P. polyphemoides* were represented by only single specimens in a few samples; *P. intermedius* on the other hand, was found in a good number of samples (Table 22), and this species is thus doubtless the most important of the three as regards the food of the herring.

Table 22. Occurrence of Podon intermedius in plankton samples, and of the genus Podon in herring samples. Rudkøbing.



Copepoda.

As already mentioned, copepods are found in the food of a relatively large number of herring. In November and December, however, the percentage of herring containing copepods is relatively small, and copepods are on the

whole found in the food of a smaller number of herring during the latter half of the year than in the first. This is apparent from the figures given in Table 23 showing the monthly percentages of herring containing copepods.

Table 23. Monthly percentages of herring containing copepods. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	75.0 (9 : 12)	75.0 (6 : 8)	20.0 (6 : 30)	42.9 (12 : 28)
1924	x	x	x	94.7 (18 : 19)	90.6 (29 : 32)	94.1 (16 : 17)	66.7 (18 : 27)	28.6 (4 : 14)	57.1 (8 : 14)	50.0 (8 : 16)	27.8 (5 : 18)	16.7 (1 : 6)
1925	x	x	42.9 (3 : 7)	85.7 (24 : 28)	83.3 (30 : 36)	46.7 (7 : 15)	—	66.7 (2 : 3)	50.0 (5 : 10)	100.0 (6 : 6)	x	x
1926	100.0 (8 : 8)	97.3 (36 : 37)	x	62.5 (5 : 8)	x	x	x	x	x	x	x	x

The difference in the importance of copepods as food for the herring at different seasons is even more distinctly apparent when we consider the average number of copepods per fish for the different months (Table 24).

Table 24. Average number of copepods, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	2 (17 : 9)	3 (18 : 6)	4 (26 : 6)	78 (931 : 12)
1924	x	x	x	71 (1287 : 18)	112 (3255 : 29)	105 (1681 : 16)	2 (31 : 18)	2 (9 : 4)	12 (99 : 8)	1 (10 : 8)	2 (10 : 5)	5 (5 : 1)
1925	x	x	38 (113 : 3)	456 (10938 : 24)	9 (267 : 30)	5 (35 : 7)	—	3 (7 : 2)	3 (13 : 5)	4 (26 : 6)	x	x
1926	21 (171 : 8)	478 (17192 : 36)	x	15 (75 : 5)	x	x	x	x	x	x	x	x

From this it appears that the greatest quantities of copepods in the different years are found in different months, but all in the first half of the year. The quantities of copepods from July to November are very small compared with those for the remaining months. In December, the number of copepods in the stomachs of the herring was in one year (1923) remarkably great. We find then, that copepods appear in the food of a relatively large number of herring the whole year round, but that in quantitative respects, they are only of any essential importance as herring food in the first half of the year. This applies, however, only to adult herring (over 18 cm. length); for if we take the data for young herring (less than 18 cm.) we find that these feed on copepods to a relatively great extent also in autumn, as Table 25 shows. The number of copepods per fish in Sept. 1925 varied from 1—5 for adult herring, whereas for young herring, the range of variation was 12—100.

Table 25. Average number of copepods per young herring and average per adult fish in the respective months. Rudkøbing.

	January 1926	February 1926	June 1924	September 1925
Total length of fish in cm.	11—17	12—17	11—15	9—11
No. of copepods in the spec. examined	611	2470	1574	312
No. of fish containing copepods	9	4	11	10
Average no. of copepods per young herring	**68**	**617**	**143**	**31**
Average no. of copepods per adult herring	**21**	**478**	**105**	**3**

The fact that adult herring, from July to November inclusive, only consume small numbers of copepods, must be ascribed to the inclination of the fish themselves alone. Proof of this has already been furnished by the fact that young herring — in contrast to the adults — will at this time of year devour considerable quantities of copepods. The commonest copepods also occur in great quantities in the plankton during this period.

The following copepods have been found in the food of herring from Rudkøbing:

Calanus finmarchicus (Gunner.)
Pseudocalanus elongatus Boeck
Paracalanus parvus Claus
Centropages hamatus (Lillj.)
Isias clavipes Boeck
Temora longicornis (O. F. Müller)
Acartia longiremis (Lillj.)
Acartia bifilosa (Giesbrecht)
Oithona similis Claus
Microsetella norvegica (Boeck)
Harpacticus gracilis Claus.

In very many cases, especially with the young stages, it was impossible to distinguish between the two species *Pseudocalanus elongatus* and *Paracalanus parvus*, and the two have therefore been taken together in the calculations. It was also frequently difficult to identify the different species of the genus *Acartia* in the stomach contents, and these are therefore likewise taken together. The relatively few specimens of harpacticids found in the stomach contents were as a rule young ones, and for the most part, determination of species was out of the question.

The relative importance of the different copepods as food for the herring in the different months will be seen from Table 26, which shows for each month, the total number of specimens of each species noted in the stomach analyses and the relative numbers of the various species.

Table 26. Relative importance of the various copepods as food for adult herring during the different months. Rudkøbing.

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Calanus finmarchicus . .	1	0.86	—	—	—	—	12	0.10	7	0.22	3	0.19	—	—	—	—	—	—	—	—	—	—	—	—
Pseudocal.+ Paracalanus	94	81.03	909	5.76	5	7.35	6710	59.15	2599	80.89	939	59.20	4	12.90	7	43.75	20	16.81	21	58.33	1	3.85	—	—
Centropages hamatus . .	3	2.59	47	0.30	32	47.06	2071	18.26	120	3.74	170	10.72	15	48.39	3	18.75	55	46.22	7	19.44	4	15.38	34	4.66
Isias clavipes	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	12.50	—	—	2	5.56	—	—	—	—
Temora longicornis	15	12.93	14761	93.65	26	38.24	2442	21.53	235	7.31	324	20.43	9	29.03	3	18.75	42	35.29	3	8.33	20	76.92	694	95.20
Acartia sp.	3	2.59	36	0.23	4	5.88	101	0.89	243	7.56	143	9.02	3	9.68	1	6.25	1	0.84	2	5.56	—	—	1	0.14
Oithona similis	—	—	—	—	1	1.47	2	0.02	2	0.06	—	—	—	—	—	—	1	0.84	—	—	—	—	—	—
Harpacticidæ	—	—	9	0.06	—	—	6	0.05	7	0.22	7	0.44	—	—	—	—	—	—	1	2.78	1	3.85	—	—

Looking at the figures for the various months, we find that the copepods are chiefly either *Pseudocalanus + Paracalanus* or *Temora, Centropages hamatus* coming next in importance as herring food. Taking the whole of the available material together, we obtain the following absolute and relative values for the different species:

Temora longicornis	18 574 spec.	56.21 %
Pseudocalanus + Paracalanus	11 309 —	34.22 —
Centropages hamatus	2 561 —	7.75 —
Acartia sp.	538 —	1.63 —
Harpacticidæ	31 —	0.09 —
Calanus finmarchicus	23 —	0.07 —
Oithona similis	6 —	0.02 —
Isias clavipes	4 —	0.01 —

This method of calculation shows *Temora* as of considerably greater importance than *Pseudocalanus + Paracalanus*. This is due more especially to the fact that *Temora* was found in unusually great numbers in one particular month (February). *Centropages hamatus* amounts to only 7.75 % of the total number of copepods, and the genus *Acartia* no more than 1.63 %. The remaining copepods are practically negligible as herring food.

In the foregoing calculations, we have of course, considered only those copepods which could be referred to their definite species, or to one of the groups. Unidentifiable copepods however, constitute only 8—9 % of the total, and could thus hardly affect the results to any essential degree.

A further indication of the importance of various copepods as herring food is given in Table 27 showing the monthly percentages of herring in which the different copepods were found as constituents in the food.

Table 27. Monthly percentages of herring containing the different copepods. Rudkøbing.

	1923				1924									1925								1926		
	Sept.	Oct.	Nov.	Dec.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Jan.	Feb.	Apr.
Calanus finmarchicus . .	—	—	—	—	31.6	9.4	11.8	—	—	—	—	—	—	—	3.6	—	6.7	—	—	—	—	12.5	—	—
Pseudocal. + Paracalanus	8.3	50.0	3.3	—	57.9	75.0	94.1	11.1	14.3	35.7	25.0	—	—	14.3	85.7	58.3	33.3	—	66.7	40.0	66.7	50.0	67.6	—
Centropages hamatus .	25.0	25.0	3.3	17.9	5.3	43.7	52.9	40.7	14.3	35.7	18.7	16.7	—	42.9	67.9	44.4	40.0	—	—	10.0	33.3	12.5	13.5	12.5
Isias clavipes	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	66.7	—	16.7	—	—	—
Temora longicornis	50.0	—	13.3	39.3	78.9	65.6	58.8	25.9	21.4	28.6	6.2	27.8	16.7	42.9	57.1	44.4	13.3	—	—	—	16.7	75.0	86.5	37.5
Acartia sp.	—	—	—	3.6	57.9	37.5	47.1	11.1	7.1	7.1	6.2	—	—	14.3	25.0	33.3	13.3	—	—	—	16.7	25.0	24.3	25.0
Oithona similis	—	—	—	—	—	3.1	—	—	—	—	—	—	—	14.3	7.1	2.8	—	—	—	10.0	—	—	—	—
Harpacticidæ	—	—	3.3	—	10.5	15.6	17.6	—	—	—	6.2	—	—	—	—	5.6	6.7	—	—	—	—	—	13.5	12.5

The table shows that *Pseudocalanus + Paracalanus, Centropages hamatus* and *Temora longicornis* are the copepods most frequently found in the food. Species of the genus *Acartia*, on the other hand, were found in relative few of the fish, and the remaining copepods appear only in a small percentage of the specimens examined. The copepods most frequently found all have their highest percentages during the first half of the year.

Proceeding then to consider the average numbers of the various copepods per fish, we will here take only the most important species. The monthly averages will be seen from the following table.

Table 28. Monthly averages for the principal copepods, showing number of specimens per herring containing the respective species. Rudkøbing.

	1923				1924									1925								1926		
	IX	X	XI	XII	IV	V	VI	VII	VIII	IX	X	XI	XII	III	IV	V	VI	VII	VIII	IX	X	I	II	III	IV
Pseudocal. + Paracalanus	1	2	1	0	89	102	58	1	1	3	1	0	0	5	238	7	2	0	2	1	2	23	36	x	0
Temora longicornis	1	0	3	63	12	9	32	1	1	9	1	1	5	9	139	2	2	0	0	0	2	2	461	x	15
Centropages hamatus . . .	1	1	1	7	1	6	17	1	1	10	1	1	0	11	108	3	3	0	0	1	1	3	9	x	27
Acartia sp.	0	0	0	1	3	18	18	1	1	1	1	0	0	4	10	2	2	0	0	0	1	1	4	x	2

The numbers of copepods found in individual stomach contents varies of course very much from one fish to another in the same sample; this mode of calculation, however, affords quite a good illustration of the fact that all the most important copepods are far more abundant in spring, and to some extent also in winter, than during the rest of the year.

Calanus finmarchicus. In the Rudkøbing waters, this species counts for very little indeed in the food of the herring. The stomach analyses yielded 23 specimens, from 14 fish. The greatest number found in any one herring was 4. The species appeared in the food for the months of January, April, May and June. Correspondingly, it was only found in the plankton samples from January to June, and then always in small numbers.

Pseudocalanus elongatus and *Paracalanus parvus.* As already mentioned, no distinction was made between these two species in the stomach analyses, and they are therefore taken together in the following. *Pseudocalanus* and *Paracalanus* constitute together 34.22 % of the total of copepods found in the stomach contents of the Rudkøbing herring, and are thus of great importance as herring food in these waters.

Table 29. Monthly percentages of herring containing Pseudocalanus + Paracalanus. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	8.3 (1 : 12)	50.0 (4 : 8)	3.3 (1 : 30)	—
1924	x	x	x	57.9 (11 : 19)	75.0 (24 : 32)	94.1 (16 : 17)	11.1 (3 : 27)	14.3 (2 : 14)	35.7 (5 : 14)	25.0 (4 : 16)	—	—
1925	x	x	14.3 (1 : 7)	85.7 (24 : 28)	58.3 (21 : 36)	33.3 (5 : 15)	—	66.7 (2 : 3)	40.0 (4 : 10)	66.7 (4 : 6)	x	x
1926	50.0 (4 : 8)	67.6 (25 : 37)	x	—	x	x	x	x	x	x	x	x

Table 29 shows that the numbers of herring containing these two species were particularly great in the months of April, May and June, and extremely small in November and December. A further idea as to the importance of these copepods as herring food is afforded by consideration of the quantities in which they appeared in the stomach contents.

Table 30. Average number of Pseudocalanus + Paracalanus, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	1 (1 : 1)	2 (8 : 4)	1 (1 : 1)	—
1924	x	x	x	89 (975 : 11)	102 (2454 : 24)	58 (929 : 16)	1 (4 : 3)	1 (2 : 2)	3 (13 : 5)	1 (4 : 4)	—	—
1925	x	x	5 (5 : 1)	238 (5715 : 24)	7 (154 : 21)	2 (10 : 5)	—	2 (5 : 2)	1 (6 : 4)	2 (9 : 4)	x	x
1926	23 (94 : 4)	36 (909 : 25)	x	—	x	x	x	x	x	x	x	x

The table shows that the number of these copepods in the stomachs of the herring is far greater in the first six months of the year than in the latter half. The greatest numbers are found in April and May, but January and February already show quite considerable figures. Despite the fact that it was impossible to distinguish between the two species in the stomach analyses, it will be interesting nevertheless to compare the results of these with the occurrence of the two species in the plankton samples. The figures for both are given below.

Table 31. Pseudocalanus elongatus and Paracalanus parvus. Occurrence in plankton samples and in herring samples. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples:												
Pseudocalanus elongatus 1923									⊗ ⊗	● ⊗	⊗ ⊗ ●	⊗ ⊗ ●
Pseudocalanus elongatus 1924				● ●	● ⊗ ●	● ● ⊗	⊗ ⊗ ⊗	⊗ ○	○ ⊗ ⊗	⊗ ⊗	● ⊗ ●	● ●
Pseudocalanus elongatus 1925			● ⊗ ⊗	● ● ●	● ● ⊗	⊗ ⊗ ⊗	⊗	○	⊗ ⊗	⊗		
Pseudocalanus elongatus 1926	⊗ ●	● ●	⊗	●								
Paracalanus parvus 1923									● ●	● ●	⊗ ⊗ ●	⊗ ⊗ ○
Paracalanus parvus 1924				⊗ ⊗	⊗ ○ ⊗	● ● ○	⊗ ○ ⊗	⊗ ●	● ● ●	● ●	● ● ●	● ●
Paracalanus parvus 1925			⊗ ⊗ ⊗	⊗ ⊗ ⊗	⊗ ⊗ ⊗	⊗ ⊗ ●	●	●	● ●	●		
Paracalanus parvus 1926	○ ⊗	⊗ ⊗	⊗	⊗								
Herring samples:												
Pseudocalanus + Paracalanus 1923									⊕ ○	⊕ ○	⊕ ○ ○	○ ○ ○
Pseudocalanus + Paracalanus 1924				⊕ ⊕	⊕ ⊕ ○	⊕ ⊕	⊕ ⊕ ⊕	⊕	○ ⊕ ⊕	⊕ ⊕ ○	○ ○ ○	○
Pseudocalanus + Paracalanus 1925			⊕ ○ ○	⊕ ⊕ ⊕	⊕ ⊕ ⊕	⊕ ○	○	⊕	⊕ ⊕	⊕		
Pseudocalanus + Paracalanus 1926	○ ⊕	⊕ ⊕		○								

It will be seen that *Pseudocalanus* is by far the commoner of the two species in spring, and also during part of the winter, *Paracalanus* being numerous especially in the autumn. In spring, then, it is undoubtedly *Pseudocalanus* which constitutes the principal food of the herring, *Paracalanus* being of but subordinate importance in this connection. We find also, from the examination of a few of the fish taken in April and May, in which the stomach contents were exceptionally well preserved, that at least 95 % of the organisms referred to the two species, consisted of *Pseudocalanus*. In autumn, as mentioned, the two species are found in but small numbers in the stomachs of the herring, though *Paracalanus* is then very common in the plankton samples. And in November and December, when the species are practically non-existent in the food of the herring, both are common in most of the plankton samples.

Centropages hamatus. This species constitutes 7.75 % of the total number of copepods found in the food of the Rudkøbing herring.

Table 32. Monthly percentages of herring containing Centropages hamatus. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	25.0 (3 : 12)	25.0 (2 : 8)	3.3 (1 : 30)	17.9 (5 : 28)
1924	x	x	x	5.3 (1 : 19)	43.7 (14 : 32)	52.9 (9 : 17)	40.7 (11 : 27)	14.3 (2 : 14)	35.7 (5 : 14)	18.7 (3 : 16)	16.7 (3 : 18)	—
1925	x	x	42.9 (3 : 7)	67.9 (19 : 28)	44.4 (16 : 36)	40.0 (6 : 15)	—	—	10.0 (1 : 10)	33.3 (2 : 6)	x	x
1926	12.5 (1 : 8)	13.5 (5 : 37)	x	12.5 (1 : 8)	x	x	x	x	x	x	x	x

It will be seen from the above that this species was found in the food of a comparatively large number of herring in most of the months, but with an indubitable maximum from March—July.

Considering now the average number of *Centropages* per fish in which it was found (Table 33) it will be noticed that the greatest numbers are found in spring and early summer.

Table 33. Average number of Centropages hamatus, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	1 (4 : 3)	1 (2 : 2)	1 (1 : 1)	7 (34 : 5)
1924	x	x	x	1 (1 : 1)	6 (79 : 14)	17 (153 : 9)	1 (15 : 11)	1 (3 : 2)	10 (50 : 5)	1 (3 : 3)	1 (3 : 3)	—
1925	x	x	11 (32 : 3)	108 (2043 : 19)	3 (41 : 16)	3 (17 : 6)	—	—	1 (1 : 1)	1 (2 : 2)	x	x
1926	3 (3 : 1)	9 (47 : 5)	x	27 (27 : 1)	x	x	x	x	x	x	x	x

Centropages hamatus is common in the plankton samples from most months of the year, as will be seen from Table 34 below. It appears then, that this species, like various other copepods, occurs in the plankton in quite considerable quantities at the different seasons, but is of no essential importance as food for the herring except in spring.

Table 34. Centropages hamatus. Occurrence in plankton samples and in herring samples. Rudkøbing.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									●⊗	●⊗	⊗●●	⊗⊗⊗
	1924				●⊗	●●⊗	⊗●●	●●●	●●	●●⊗	●●	⊗●●	●●
	1925			⊗●●	●●●	●●●	●●●	●	⊗	⊗ ○	⊗		
	1926	●●	●●	●	●								
Herring samples	1923									⊕⊕	⊕○	⊕○○	○○⊕
	1924				⊕○	⊕⊕○	⊕⊕	⊕⊕⊕	⊕	○⊕⊕	⊕⊕⊕	⊕⊕⊕	
	1925			⊕○⊕	⊕⊕⊕	○⊕⊕	⊕⊕	○	○	○ ⊕	⊕		
	1926	○⊕	⊕⊕		⊕								

Isias clavipes. This species, which occurs only in small numbers in the inner Danish waters, has been found in the food of adult herring from Rudkøbing, $^{20}/_{8}$ and $^{6}/_{10}$ 25 and young herring $^{10}/_{9}$ 25. It was noted several times in the plankton samples, and was particularly numerous in 1925, as will be seen from Table 35.

It will be observed that *Isias clavipes* was only found in plankton samples from July to early November. This agrees well with earlier statements as to the occurrence of the species in the inner Danish waters (Jensen, Johansen & Levinsen 1903, p. 305) where it is noted as found off Knudshoved (Great Belt) from mid-August to early November. In the sample of young herring (8 spec.), taken on the $^{10}/_{9}$ 25, the species was found in the stomach contents of all the fish, in numbers ranging from 5 to 14.

Table 35. Isias clavipes. Occurrence in plankton samples and in herring samples. Rudkøbing.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									○⊗	○○	○○○	○○○
	1924				○○	○○○	○○○	○○○	○○	⊗○○	⊗○	⊗○○	○○
	1925			○○○	○○○	○○○	○○○	●	●	● ○	⊗		
	1926	○○	○○	○	○								
Herring samples	1923									○○	○○	○○○	○○○
	1924				○○	○○○	○○	○○○	○	○○○	○○○	○○○	○
	1925			○○○	○○○	○○○	○○	○	⊕	⊕ ○	⊕		
	1926	○○	○○		○								

Temora longicornis. This species is one of the most important items in the food of the Rudkøbing herring. It amounts to 56.21 % of the total number of copepods found in the stomach analyses. The monthly percentages of herring containing *Temora* will be found in Table 36.

Table 36. Monthly percentages of herring containing Temora longicornis. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	50.0 (6 : 12)	—	13.3 (4 : 30)	39.3 (11 : 28)
1924	x	x	x	78.9 (15 : 19)	65.6 (21 : 32)	58.8 (10 : 17)	25.9 (7 : 27)	21.4 (3 : 14)	28.6 (4 : 14)	6.2 (1 : 16)	27.8 (5 : 18)	16.7 (1 : 6)
1925	x	x	42.9 (3 : 7)	57.1 (16 : 28)	44.4 (16 : 36)	13.3 (2 : 15)	—	—	—	16.7 (1 : 6)	x	x
1926	75.0 (6 : 8)	86.5 (32 : 37)	x	37.5 (3 : 8)	x	x	x	x	x	x	x	x

The greatest numbers of herring containing *Temora* are found in the first six months of the year. The same holds good, in the main, when we consider the average numbers of *Temora* per fish for the different months (Table 37). From July to November (incl.) *Temora* is of but very slight importance as herring food. The high averages for December 1923 and February 1926 show that this copepod can occur in great numbers in the food of the herring in winter. The greatest number of *Temora* found in a single stomach (Feb. 1926) amounts to no less than about 2600 specimens.

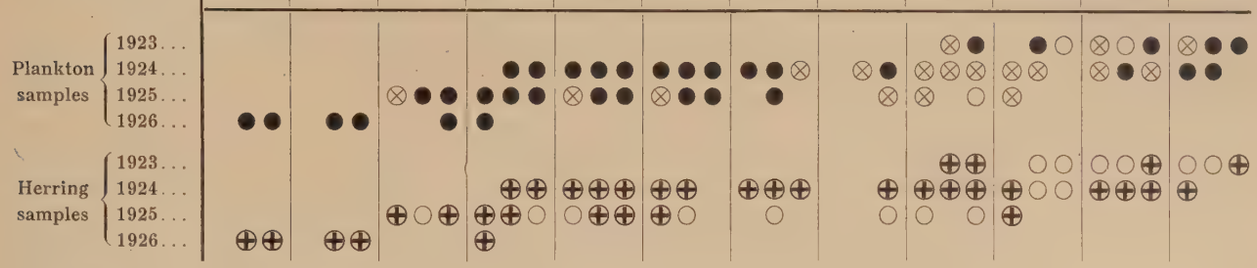
Table 37. Average number of Temora longicornis, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	1 (8 : 6)	—	3 (14 : 4)	63 (689 : 11)
1924	x	x	x	12 (177 : 15)	9 (199 : 21)	32 (320 : 10)	1 (9 : 7)	1 (3 : 3)	9 (35 : 4)	1 (1 : 1)	1 (6 : 5)	5 (5 : 1)
1925	x	x	9 (26 : 3)	139 (2221 : 16)	2 (36 : 16)	2 (4 : 2)	—	—	—	2 (2 : 1)	x	x
1926	2 (15 : 6)	461 (14761 : 32)	x	15 (44 : 3)	x	x	x	x	x	x	x	x

Examination of the occurrence of *Temora* in the plankton samples shows that it was common or numerous in a great number of these, but was on the whole less frequent from August to November (Table 38). In December, and the rest of the winter months, it was common in the great majority of plankton samples investigated, a point worth consideration in conjunction with the fact that the species has been noted as abundant in the food of the herring for some of the winter months.

Acartia sp. As already mentioned, it was impossible, in the stomach analyses, to refer all organisms of the genus *Acartia* to their respective species. *A. longiremis* and *A. bifilosa* are the only forms identified with certainty in the food. Compared with other copepods, the genus *Acartia* plays but a subordinate part in the food of the herring

Table 38. Temora longicornis. Occurrence in plankton samples and in herring samples. Rudkøbing.



in these waters (1,63 % of the total no. of copepods). On examining the relative numbers of herring with *Acartia* in the stomachs (Table 39), it will be found that the percentage is fairly high for the first six months of the year.

Table 39. Monthly percentages of herring containing Acartia. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	—	3.6 (1 : 28)
1924	x	x	x	57.9 (11 : 19)	37.5 (12 : 32)	47.1 (8 : 17)	11.1 (3 : 27)	7.1 (1 : 14)	7.1 (1 : 14)	6.2 (1 : 16)	—	—
1925	x	x	14.3 (1 : 7)	25.0 (7 : 28)	33.3 (12 : 36)	13.3 (2 : 15)	—	—	—	16.7 (1 : 6)	x	x
1926	25.0 (2 : 8)	24.3 (9 : 37)	x	25.0 (2 : 8)	x	x	x	x	x	x	x	x

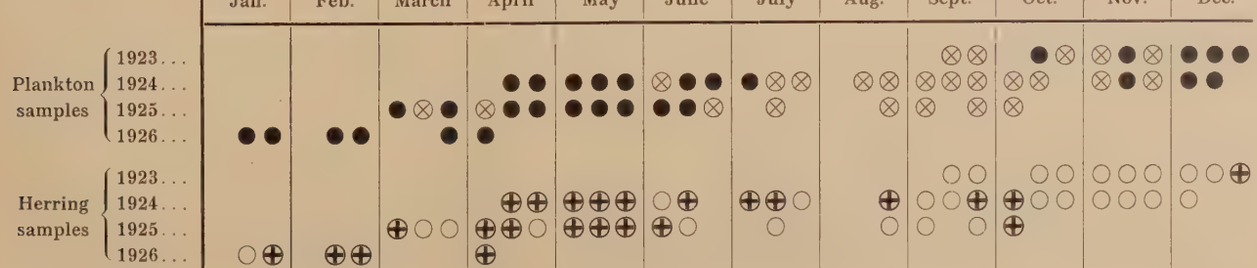
The number of herring containing *Acartia* is thus fairly large, but in comparison with most of the other copepods, the number of specimens found in each fish is on the average but small, as will be seen from the table below.

Table 40. Average number of Acartia, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	—	1 (1 : 1)
1924	x	x	x	3 (31 : 11)	18 (220 : 12)	18 (141 : 8)	1 (3 : 3)	1 (1 : 1)	1 (1 : 1)	1 (1 : 1)	—	—
1925	x	x	4 (4 : 1)	10 (67 : 7)	2 (23 : 12)	2 (4 : 2)	—	—	—	1 (1 : 1)	x	x
1926	1 (3 : 2)	4 (36 : 9)	x	2 (5 : 2)	x	x	x	x	x	x	x	x

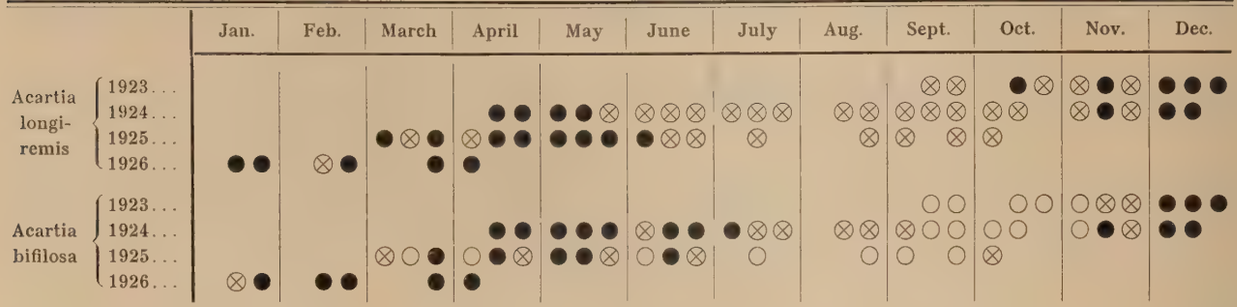
The genus *Acartia* is, as a rule, common in the plankton samples throughout all months of the year, save from July to November (see Table 41).

Table 41. Acartia sp. Occurrence in plankton samples and in herring samples. Rudkøbing.



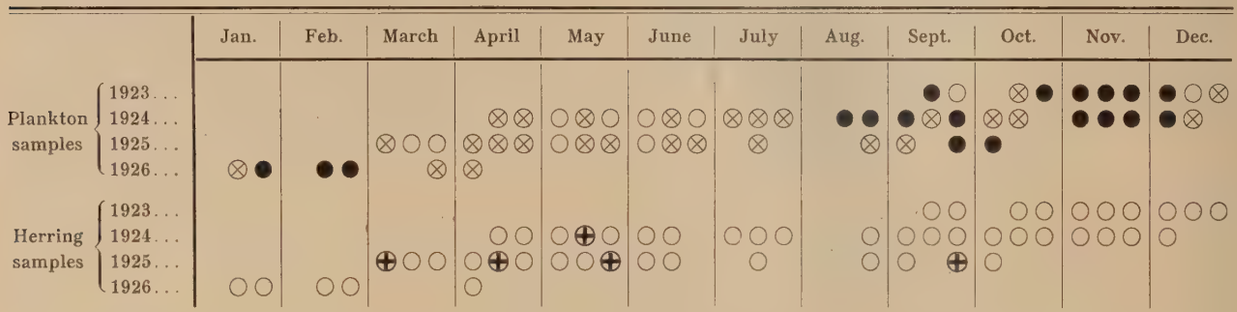
The occurrence of the genus in the plankton samples, as will be seen, corresponds fairly well with its appearance in the food of the herring, save in the case of the early winter months. At this time of year, *Acartia* is often common in the plankton samples, but appears only in very small numbers in the herring food. *A. longiremis* and *A. bifilosa* are the commonest forms in the plankton samples from Rudkøbing. Some few specimens of *A. Clausi* Giesbrecht have also occasionally been found in the autumn, and a solitary specimen of *A. discaudata* (Giesbrecht) was taken on the $^{21}/_{9}$ 25. The table below, giving the occurrence of *A. longiremis* and *A. bifilosa* in the plankton samples, shows a nice agreement between the figures for both species at the different seasons. In most cases, *A. longiremis* is the more numerous.

Table 42. Acartia longiremis and Acartia bifilosa. Occurrence in plankton samples. Rudkøbing.



Oithona similis. Only 6 specimens of this species were found in the stomachs examined. The fact of its being so rarely found in the food of the herring is doubtless due to its being neglected by the fish on account of its small size. As will be seen from Table 43 it is numerous, more especially in the autumn and winter, in the Rudkøbing waters.

Table 43. Oithona similis. Occurrence in plankton samples and in herring samples. Rudkøbing.



Harpacticidæ. In the stomach analyses of herring from Rudkøbing, a few harpacticids were found in the food. The specimens were mostly young ones, and it was therefore as a rule impossible to determine the species. The only certain identifications were those of *Microsetella norvegica*, $^{17}/_{2}$ 26, and *Harpacticus gracilis*, $^{25}/_{4}$ 24. No harpacticids were observed in the plankton samples from Rudkøbing.

Cirripedia.

Cirripede larvæ are not infrequently found in the food of the herring from Rudkøbing, but for the most part only in small numbers. In April, the cirripede larvæ appear in a comparatively large number of the stomachs examined, but never in those of fish taken during the months of July, August or September. In winter, they are met with occasionally in the food; specimens were found, for instance, in the stomach contents of herring in December and February, as noted in Table 44. Two specimens were also found in the stomach of a young herring (13 cm. length) taken in January 1926.

As already noted, cirripede larvæ appear as a rule in but small numbers in the stomach contents of the herring; we find an exception however, in the case of a fish taken on the $^{5}/_{4}$ 26, which was found to contain no fewer than 650 specimens (cypris stages). Disregarding April 1926, the monthly average per fish lies between 1 and 4.

Table 44. Monthly percentages of herring containing cirripede larvæ. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	—	3.6 (1 : 28)
1924	x	x	x	31.6 (6 : 19)	15.6 (5 : 32)	5.9 (1 : 17)	—	—	—	—	11.1 (2 : 18)	—
1925	x	x	—	10.7 (3 : 28)	—	—	—	—	—	16.7 (1 : 6)	x	x
1926	—	5.4 (2 : 37)	x	37.5 (3 : 8)	x	x	x	x	x	x	x	x

Cirripede larvæ have often been found in the plankton samples, but only twice in such quantity that they could be noted as common, viz. on the $^{25}/_{4}$ 24 and $^{28}/_{2}$ 26. The table below giving the occurrence of cirripede larvæ, shows that they are found in the plankton samples for all months of the year with the exception of July and August.

Table 45. Occurrence of cirripede larvæ in plankton samples and in herring samples. Rudkøbing.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									⊗⊗	○○	○○⊗	⊗○⊗
	1924				⊗●	⊗○○	○○○	○○○	○○	○○○	○⊗	⊗⊗○	○⊗
	1925			⊗○○	⊗○○	⊗○⊗	○⊗○	○	○	○ ⊗	○		
	1926	○⊗	⊗●	○	⊗								
Herring samples	1923									○○	○○	○○○	○○⊕
	1924				⊕⊕	⊕⊕○	○⊕	○○○	○	○○○	○○○	⊕⊕○	○
	1925			○○○	○⊕○	○○○	○○	○	○	○ ○	⊕		
	1926	○⊕	⊕○		⊕								

This agrees well in the main with the herring samples, in which cirripede larvæ appear in the food of the herring[1]). Closer analysis of the various stages of development, in plankton and herring samples however, reveals the peculiar fact that nauplii are largely predominant in the plankton samples, whereas cypris stages are decidedly more numerous in the stomach contents. The explanation is probably that the nauplii live a more pelagic life than the cypris stages, and are therefore more liable to be taken in pelagic nets. The marked predominance of the cypris stages in the food, on the other hand, must doubtless be taken as indicating a preference on the part of the herring for these as compared with the nauplii. Figures illustrating these points are given in the list below, showing the dates on which the two stages were found in plankton and herring samples respectively.

		Nauplii	Cypris stages
Plankton samples	1923:	$^{19}/_{9}$, $^{29}/_{9}$, $^{21}/_{11}$, $^{4}/_{12}$, $^{21}/_{12}$	
	1924:	$^{14}/_{4}$, $^{25}/_{4}$, $^{5}/_{5}$, $^{10}/_{10}$, $^{7}/_{11}$, $^{17}/_{11}$, $^{18}/_{12}$	$^{25}/_{4}$
	1925:	$^{1}/_{3}$, $^{2}/_{4}$, $^{4}/_{5}$, $^{20}/_{5}$, $^{11}/_{6}$, $^{21}/_{9}$	$^{21}/_{9}$
	1926:	$^{17}/_{2}$, $^{28}/_{2}$, $^{5}/_{4}$	$^{31}/_{1}$, $^{28}/_{2}$
Herring samples	1923:		$^{21}/_{12}$
	1924:	$^{25}/_{4}$	$^{14}/_{4}$, $^{25}/_{4}$, $^{5}/_{5}$, $^{14}/_{5}$, $^{13}/_{6}$, $^{7}/_{11}$, $^{17}/_{11}$
	1925:	$^{14}/_{4}$	$^{14}/_{4}$, $^{6}/_{10}$
	1926:		$^{31}/_{1}$, $^{17}/_{2}$, $^{5}/_{4}$.

It will be observed that nauplii were found in 21 of the plankton samples examined, but only in 2 herring samples as food. Cypris stages, on the other hand, appear in only 4 of the plankton samples, but were found as part of the stomach contents in 13 herring samples.

Mysidacea.

The Rudkøbing herring live to a great extent on mysids. As a rule however, the average number of mysids per fish is far below that of, say, copepods. On the other hand, the food value of a mysid being many times that

[1]) In the table above showing occurrence of cirripede larvæ in the herring samples, the one sample from January 1926 is included as positive, cirripede larvæ having been found in the stomach contents of young herring during this month (*vide supra*).

of a copepod, the mysids, despite the inferiority of their absolute numerical value, constitute a very important item in the food of the herring.

Table 46 shows that mysids are found in the stomach contents of herring in nearly every month of the year, though the percentages for the individual months vary greatly.

Table 46. Monthly percentages of herring containing mysids. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	25.0 (3 : 12)	—	33.3 (10 : 30)	78.6 (22 : 28)
1924	x	x	x	5.3 (1 : 19)	3.1 (1 : 32)	11.8 (2 : 17)	29.6 (8 : 27)	7.1 (1 : 14)	21.4 (3 : 14)	18.7 (3 : 16)	61.1 (11 : 18)	16.7 (1 : 6)
1925	x	x	14.3 (1 : 7)	3.6 (1 : 28)	5.6 (2 : 36)	20.0 (3 : 15)	50.0 (1 : 2)	33.3 (1 : 3)	—	16.7 (1 : 6)	x	x
1926	—	2.7 (1 : 37)	x	—	x	x	x	x	x	x	x	x

From January to May—June, the percentage is low, but in the latter half of the year often considerably higher. It is worth noting that in spring, when copepods are most abundant in the food of the herring, mysids are found only in a comparatively small number of the fish. The average numbers of mysids per herring for the different months will be seen from the table below.

Table 47. Average number of mysids, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	1 (3 : 3)	—	13 (132 : 10)	23 (506 : 22)
1924	x	x	x	1 (1 : 1)	1 (1 : 1)	2 (5 : 2)	7 (54 : 8)	3 (3 : 1)	2 (6 : 3)	1 (3 : 3)	1 (12 : 11)	1 (1 : 1)
1925	x	x	1 (1 : 1)	1 (1 : 1)	2 (4 : 2)	2 (5 : 3)	2 (2 : 1)	1 (1 : 1)	—	1 (1 : 1)	x	x
1926	—	1 (1 : 1)	x	—	x	x	x	x	x	x	x	x

The high averages for November and December 1923 show that at this season, in 1923, mysids were unusually numerous in the stomach contents. One fish was found to contain no fewer than 156 mysids. The unusual abundance of mysids in the food of the herring in November and December 1923 is very remarkable, and can hardly be due to unusual abundance of mysids generally at this season. Blegvad (1922, p. 97) at any rate notes, from investigations in Nyborg Fjord, "that the greatest numbers of our 3 common Mysis-species are met with in the autumn, during August and September, when the young of as well summer-stock as winter-stock have appeared". It seems thus to be no common occurrence to find the stock of mysids particularly large so late in the year. In this connection, it is worth while drawing attention to the fact that amphipods also were found in unusual abundance in the food of the herring in November and December 1923 (see p. 39).

As mysids are often found in a state of dissolution in the stomach contents, it was not possible to identify all the available material; about 78 % of the total number of mysids were, however, recognisable as regards species. The following were noted in the food of the herring:

Gastrosaccus spinifer (Goës)
Macropsis Slabberi (v. Bened.)
Macromysis inermis (Rathke)
Macromysis flexuosa (O. F. Müller)
Macromysis neglecta (G. O. Sars)
Schistomysis spiritus Norm.
Schistomysis ornata (G. O. Sars).

Very often several species of mysids are found in the stomach of a single fish. It is not uncommon to find as many as 2—3 different species; as a rule however, a single species is numerically predominant. A characteristic example of this is afforded by Table 48 showing the numbers of mysids of 4 different species found in the stomach contents of 16 herring taken in December 1923.

Table 48. Number of specimens of different mysid species in the stomach contents of 16 herring from Rudkøbing, $^{21}/_{12}$ 1923.

Herring No.	1497	1498	1499	1503	1504	1505	1506	1507	1508	1509	1510	1511	1512	1513	1514	1516
Gastrosaccus spinifer.	4	16	42	3	4	..	12	..	..	..	1	8	..	5	4	1
Macromysis inermis ..	2	1	..	..	..	..	120	5	3	3	..	5	..	..	..	19
Macromysis flexuosa..	..	..	..	1	..	75	..	..	..	..	..	..	..	..	..	..
Macromysis neglecta..	..	..	..	..	..	..	16	..	..	..	..	2	19	1	..	12

The total number of identified mysids from the stomach analyses is 571, the numbers and percentages of the different species being as follows:

Gastrosaccus spinifer	193 spec.	33.8 %
Macromysis inermis	176 —	30.8 —
Macromysis flexuosa	86 —	15.1 —
Schistomysis spiritus	57 —	10.0 —
Macromysis neglecta	54 —	9.5 —
Macropsis Slabberi	3 —	0.5 —
Schistomysis ornata	2 —	0.3 —

The occurrence of the individual mysid species in the food of the herring is further discussed in the following survey.

Gastrosaccus spinifer. This species is the commonest of the mysids in the food of the Rudkøbing herring. The monthly percentages are shown in the table below.

Table 49. Monthly percentages of herring containing Gastrosaccus spinifer. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	16.7 (2 : 12)	—	6.7 (2 : 30)	46.4 (13 : 28)
1924	x	x	x	—	3.1 (1 : 32)	11.8 (2 : 17)	29.6 (8 : 27)	7.1 (1 : 14)	21.4 (3 : 14)	18.7 (3 : 16)	33.3 (6 : 18)	16.7 (1 : 6)
1925	x	x	—	—	5.6 (2 : 36)	13.3 (2 : 15)	50.0 (1 : 2)	—	—	—	x	x
1926	—	2.7 (1 : 37)	x	—	x	x	x	x	x	x	x	x

It is rare to find any great number of *Gastrosaccus* in the stomach of a single fish. The monthly averages per herring lie between 1 and 8; the greatest number found in a single fish is 42 ($^{21}/_{12}$ 23).

Macropsis Slabberi has only once been found ($^{14}/_{4}$ 24) in the stomach of an adult herring; two young herring taken on the $^{31}/_{1}$ 26 however, also contained single specimens.

Macromysis inermis. This species constitutes 30.8 % of the total number of mysids. There is this peculiarity in its occurrence, that it was only found in the food of the herring in November and December 1923. Taking all herring with food from these two months, *Macromysis inermis* was found in 24.1 % of them, and the average number of specimens per fish containing the species was 13.

Macromysis flexuosa was likewise only found in the stomach contents in November and December 1923. It was noted in 15.5 % of all herring containing food, from these two months, the average number per fish being 9.

Macromysis neglecta, like the two last-mentioned species, was only identified with certainty in samples from November and December 1923. In these two months, it was found in 13.8 % of the fish containing food, the average number per fish being 7.

Schistomysis spiritus. This species was found in the food at nearly all seasons, viz. in the following months: March, July, August, September and November. It appears, like the other mysids, to have been particularly numerous at the close of 1923. It was found in 6.9 % of all herring with food from Nov.—Dec. 1923, the average being 13 per fish. In the samples from the remaining months on the other hand, it appears only singly.

Schistomysis ornata. Single specimens of this species were found in two herring, $^{21}/_{11}$ 23.

Decapoda.

Adult decapods have only exceptionally been found in the stomach contents of the herring; larval stages however, were fairly common, as will be seen from Table 50.

Table 50. Monthly percentages of herring containing decapod larvæ. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	8.3 (1 : 12)	—	3.3 (1 : 30)	—
1924	x	x	x	—	3.1 (1 : 32)	5.9 (1 : 17)	3.7 (1 : 27)	7.1 (1 : 14)	14.3 (2 : 14)	—	—	—
1925	x	x	—	—	2.8 (1 : 36)	20.0 (3 : 15)	—	33.3 (1 : 3)	—	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

Decapod larvæ appear in the food of the herring from May to November inclusive. It will be noted that they are as a rule only present in a small proportion of the fish containing food, and the highest monthly average is only 4 specimens per fish. A single herring was found to contain as many as 7 specimens ($^{3}/_{6}$ 25). The following decapods were identified in the stomach analyses:

Carcinus mœnas (L.). Larval stages of crabs are the commonest decapods in the food of the herring, and only this species has been identified with certainty. Both the zoea and the megalopa larvæ were found in the stomach contents from May to November.

Crangon vulgaris Fabr. Apart from a single adult specimen, $^{21}/_{12}$ 23, only larval stages of *Crangon* were found in the food. They were always found singly, and only from May to August.

Palœmon (*Fabricii* Rathke?). An adult specimen of the genus *Palœmon* was found in the stomach of a herring on the $^{21}/_{12}$ 23.

Cumacea.

Cumacea were found in the stomach contents of herring containing food in the following relative numbers for the different months:

Table 51. Monthly percentages of herring containing cumacea. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	—	—
1924	x	x	x	—	—	—	3.7 (1 : 27)	7.1 (1 : 14)	7.1 (1 : 14)	6.2 (1 : 16)	16.7 (3 : 18)	—
1925	x	x	—	—	2.8 (1 : 36)	—	—	33.3 (1 : 3)	—	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

The herring seem to pursue the cumacea more especially in summer and autumn, but only very small numbers are found in the stomach contents. The total number recorded is 27, 10 of which were from a single fish ($^{17}/_{11}$ 24). All the cumacea found belonged to the genus *Diastylis*; the only species identified with certainty is *Diastylis Rathkei* (Krøyer).

Isopoda.

Isopods were occasionally found in a considerable number of the stomachs examined, but, they are never very numerous in the food. On the whole, they are noted far more frequently in the latter half of the year than in the first (Table 52).

None of the months covered by the investigations has a higher average than 3 specimens per fish. The greatest number found in a single stomach is 9 ($^{17}/_{7}$ 24). The isopods found in the stomach analyses belong, with a single exception, to the genus *Idothea.*

Eurydice pulchra Leach. A single specimen of this species was found in the stomach of a herring ($^{24}/_{10}$ 23).

Table 52. Monthly percentages of herring containing isopods. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	12.5 (1 : 8)	20.0 (6 : 30)	3.6 (1 : 28)
1924	x	x	x	—	—	—	18.5 (5 : 27)	14.3 (2 : 14)	14.3 (2 : 14)	18.7 (3 : 16)	38.9 (7 : 18)	16.7 (1 : 6)
1925	x	x	28.6 (2 : 7)	—	—	—	50.0 (1 : 2)	33.3 (1 : 3)	10.0 (1 : 10)	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

Idothea sp. It was very often impossible to determine the species of these isopods with certainty; *I. baltica* (Pallas) however, was found to be the commonest species, *I. viridis* (Slabber) being apparently less numerous.

Amphipoda.

As will be seen from Table 53 the herring feed only to a very slight extent on amphipods during the first half of the year, whereas in the latter half, these crustaceans are of considerable importance as an item in the diet.

Table 53. Monthly percentages of herring containing amphipods. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	25.0 (3 : 12)	—	76.7 (23 : 30)	75.0 (21 : 28)
1924	x	x	x	5.3 (1 : 19)	—	5.9 (1 : 17)	22.2 (6 : 27)	21.4 (3 : 14)	35.7 (5 : 14)	6.3 (1 : 16)	33.3 (6 : 18)	66.7 (4 : 6)
1925	x	x	—	—	—	—	—	33.3 (1 : 3)	—	—	x	x
1926	—	2.7 (1 : 37)	x	—	x	x	x	x	x	x	x	x

The average numbers per fish are shown in Table 54.

Table 54. Average number of amphipods, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	13 (40 : 3)	—	25 (580 : 23)	6 (136 : 21)
1924	x	x	x	2 (2 : 1)	—	1 (1 : 1)	6 (34 : 6)	1 (4 : 3)	3 (16 : 5)	1 (1 : 1)	1 (7 : 6)	1 (6 : 4)
1925	x	x	—	—	—	—	—	2 (2 : 1)	—	—	x	x
1926	—	6 (6 : 1)	x	—	x	x	x	x	x	x	x	x

As a rule, only small numbers of amphipods are found in a single fish; they may, however, in exceptional cases, be very numerous, as on the $^{21}/_{11}$ 23, when one fish was found to contain 303. Amphipods found in the stomach contents are often in such a state as to preclude any certain identification of species. Thus, out of a total of 835, only 697, or 83.5 %, could be identified at all, and some of these only as to the genus. The following genera and species were noted in the food of the herring from Rudkøbing:

Pontoporeia femorata Krøyer
Bathyporeia (pelagica Sp. Bate?)
Apherusa bispinosa (Sp. Bate)
Calliopius Rathkei (Zaddach)
Gammarellus sp.
Gammarus locusta L.
Ischyrocerus anguipes Krøyer
Ischyrocerus (minutus Lillj.?)
Corophium (crassicorne Bruzel.?)
Corophium Bonelli G. O. Sars.

The list below shows number of specimens, and percentages, of the respective genera.

Gammarus	593 spec.	85.1 %
Apherusa	67 —	9.6 —
Corophium	18 —	2.6 —
Pontoporeia	8 —	1.1 —
Ischyrocerus	6 —	0.9 —
Bathyporeia	2 —	0.3 —
Calliopius	2 —	0.3 —
Gammarellus	1 —	0.1 —

It will be seen from the above that *Gammarus* is by far the most numerous, the remaining genera being of but subordinate importance as food.

Pontoporeia femorata. Eight specimens of this species were found in the food, during the months of July, August, September and December.

Bathyporeia sp. A herring taken on the $^{21}/_{11}$ 23 was found to contain two specimens of this genus (*Bathyporeia pelagica*?).

Apherusa bispinosa. The number of specimens belonging to this species amounts to 9.6 % of all amphipods found in the stomach analyses, but it was only found in the following three samples of fish: $^{21}/_{11}$ and $^{4}/_{12}$ 23, and $^{14}/_{4}$ 24. A single herring in the first-named sample contained no fewer than 35 specimens of this species; otherwise, it appeared only in small numbers.

Calliopius Rathkei. Two specimens of this species were found in the herring from the $^{21}/_{11}$ 23 and $^{27}/_{7}$ 24.

Gammarellus sp. A specimen of this genus was found in the stomach contents of a herring from the $^{21}/_{11}$ 23. A plankton sample taken on the $^{2}/_{10}$ 24 contained a specimen of the species *Gammarellus homari* (J. C. Fabr.).

Gammarus locusta. This, as already mentioned, is by far the commonest of the amphipods found in the food of the herring, amounting to 85.1 % of all amphipods recorded. As will be seen from Table 55, *Gammarus* is chiefly important as food during the latter half of the year.

Table 55. Monthly percentages of herring containing Gammarus locusta. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	25.0 (3 : 12)	—	70.0 (21 : 30)	71.4 (20 : 28)
1924	x	x	x	—	—	5.9 (1 : 17)	11.1 (3 : 27)	21.4 (3 : 14)	7.1 (1 : 14)	—	11.1 (2 : 18)	33.3 (2 : 6)
1925	x	x	—	—	—	—	—	33.3 (1 : 3)	—	—	x	x
1926	—	2.7 (1 : 37)	x	—	x	x	x	x	x	x	x	x

The average number of *Gammarus* per fish varies considerably for the different months. In 1923 for instance, we have 12 for Sept., 20 for Nov., and 5 for Dec. In July 1924, the average is 7, whereas for the remaining months of 1924 it is 1—2. In Aug. 1925 and Feb. 1926 only a single *Gammarus* was found in the food. The greatest number found in a single fish is 290 ($^{21}/_{11}$ 23).

Ischyrocerus anguipes. This species was found in samples of herring from $^{21}/_{11}$ 23 and $^{27}/_{7}$ 24, only single specimens, however, in each case. On the $^{14}/_{9}$ 24, a couple of specimens were found belonging presumably to the species *Ischyrocerus minutus.*

Corophium sp. The genus *Corophium* is represented in the food at different seasons, but only in small numbers. The only species which could be identified with certainty was *Corophium Bonelli.*

Polychæta.

Polychætes appear in the food more especially in spring and summer, as will be seen from Table 56. In 1924, they were found in the stomach contents from May to Sept., and in August in a particularly large number of the herring examined, whereas in 1925, they were only found in the months of March, April and May. There is also a considerable difference in the average number of polychætes per herring for the two years.

Table 56. Monthly percentages of herring containing polychætes. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	3.3 (1 : 30)	—
1924	x	x	x	—	25.0 (8 : 32)	—	7.4 (2 : 27)	35.7 (5 : 14)	7.1 (1 : 14)	—	—	—
1925	x	x	14.3 (1 : 7)	17.9 (5 : 28)	13.9 (5 : 36)	—	—	—	—	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

Table 57. Average number of polychætes, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	1 (1 : 1)	—
1924	x	x	x	—	6 (46 : 8)	—	22 (44 : 2)	34 (172 : 5)	1 (1 : 1)	—	—	—
1925	x	x	1 (1 : 1)	1 (6 : 5)	2 (9 : 5)	—	—	—	—	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

It will be seen from the Table 57 that the number of polychætes in the food of the herring in 1924 — especially July and August — was conspicuously great compared with 1925. In July and August 1924, the following numbers were noted in the stomachs of individual fish: 1, 1, 1, 25, 30, 43, and 115. It was only possible to determine a small proportion of the polychætes found in the stomach contents, as they were very frequently in a state of advanced dissolution. Judging from the polychæte remains found in the stomach contents *Nereis* is by far the most important genus furnishing food for the herring in these waters. There are only a few certain identifications of species, viz. *Nereis pelagica* L. $^{14}/_{5}$, $^{28}/_{5}$, $^{25}/_{8}$ 1924 and *Nereis Dumerilii* (Aud. & M.-Edw.) $^{25}/_{8}$ 1924.

Gastropoda.

Larval gastropods appear as items in the food during the months of June, July and September, but their value in this respect is altogether insignificant. The greatest number found in a single fish is 3. In summer and autumn, larval gastropods are often found in great numbers in plankton samples from Rudkøbing waters (Table 58). It is thus evident that they count for very little in the food of the herring even when present in great abundance in the plankton.

Table 58. Occurrence of larval gastropods in plankton samples. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923									● ●	⊗ ⊗	⊗ ○ ○	○ ○ ○
1924				○ ○	○ ○ ○	○ ⊗ ●	● ● ●	● ⊗	● ⊗ ⊗	● ⊗	○ ⊗ ○	○ ○
1925			○ ○ ○	○ ○ ○	○ ⊗ ⊗	● ● ●	●	●	● ○	○		
1926	○ ○	○ ○	○	○								

An adult gastropod was found, in a state of advanced dissolution, in the stomach of a herring taken on $^{7}/_{11}$ 24.

Chætognatha.

Among the chætognaths, *Sagitta* was found in the stomachs of two herring from $^{25}/_{8}$ 24, one of which contained 30 specimens, the other 2. *Sagitta* was also found in two out of a sample of 8 young herring (length 9—11 cm.) taken on the $^{10}/_{9}$ 25; only one specimen, however, in each. It was found to be common in the plankton samples especially in Aug., Sept. and October (Table 59) which agrees with the data referring to its occurrence in the stomach contents.

Sagitta is thus, at times, extremely common in the plankton of these waters, and it is somewhat surprising that it should not appear more frequently in the food of the herring.

Table 59. Sagitta. Occurrence in plankton samples. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923									⊗ ●	○ ○	⊗ ⊗ ⊗	⊗ ○ ○
1924				⊗ ○	⊗ ○ ○	⊗ ⊗ ○	○ ⊗ ○	○ ●	○ ⊗ ●	⊗ ●	○ ⊗ ○	○ ⊗
1925			○ ○ ○	⊗ ○ ○	○ ⊗ ○	○ ○ ○	○	●	● ●	●		
1926	○ ○	○ ⊗	○	○								

Appendiculariæ.

The only species of appendicularians found in the food is *Oikopleura dioica* Fol. Only a single specimen was found in the adult herring samples (⁶/₁₀ 25); in a sample of young herring from the ¹⁰/₉ 25, on the other hand, it was fairly common in the stomach contents. The sample in question consisted of 8 fish, and *Oikopleura* was found in four of them, 2–3 specimens in each. This suggests that the young herring are more inclined to feed on *Oikopleura* than are the adults. *Oikopleura dioica* is common in the plankton samples especially in autumn (Table 60).

Table 60. Oikopleura dioica. Occurrence in plankton samples. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923									● ●	● ●	● ⊗ ○	○ ○ ○
1924				○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○ ○	○ ⊗ ●	● ●	● ● ●	○ ⊗
1925			○ ○ ○	○ ○ ○	○ ○ ○	⊗ ⊗ ○	⊗	●	○ ●	●		
1926	○ ○	○ ○	○	○								

Pisces.

Both fish and fish eggs were found in considerable quantity in the stomach contents of herring from Rudkøbing. We will in the following first consider the occurrence of fish, and thereafter of fish eggs, in the food.

Table 61 shows that fish were only found in the food from June to December, with a maximum about the month of August.

Table 61. Monthly percentages of herring containing fish. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	—	3.6 (1 : 28)
1924	x	x	x	—	—	11.8 (2 : 17)	18.5 (5 : 27)	28.6 (4 : 14)	21.4 (3 : 14)	6.2 (1 : 16)	5.6 (1 : 18)	—
1925	x	x	—	—	—	6.7 (1 : 15)	—	33.3 (1 : 3)	—	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

It will be noticed that the average numbers per month (Table 62) were far greater in 1924 than in 1925. In 1924, post-larval stages of various fishes were found in considerable quantities in the stomach contents, whereas very few were found in the analyses for 1925.

Table 62. Average number of fish, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	—	1 (1 : 1)
1924	x	x	x	—	—	1 (2 : 2)	2 (11 : 5)	25 (100 : 4)	21 (63 : 3)	1 (1 : 1)	1 (1 : 1)	—
1925	x	x	—	—	—	2 (2 : 1)	—	1 (1 : 1)	—	—	x	x
1926	—	—	x	—	x	x	x	x	x	x	x	x

The fish found in the stomachs of the herring were in such a state of dissolution that it was only possible to determine species in a small number of cases.

Gobius sp. Two samples ($^{21}/_{12}$ 23 and $^{17}/_{7}$ 24) were found to contain, one an adult specimen, the other a post-larva of this genus.

Ammodytes sp. Young specimens of *Ammodytes* constitute an essential part of the fish element in the stomach contents, and there can be little doubt that most of the remains of fish found in the stomachs represent *Ammodytes.* They appear in the food from June to November inclusive, but never in great numbers, the maximum for a single herring being 5.

Ammodytes sp. and *Clupea sp.* In the stomach contents of herring from $^{25}/_{8}$ and $^{2}/_{9}$ 24, considerable quantities of elongated fish larvæ were found. They were in such a state of dissolution that it was impossible to identify them with certainty, but they appeared to be mainly post-larval stages of the genera *Ammodytes* and *Clupea.* These were found in two stomachs from each of the samples mentioned, the numbers being: $^{25}/_{8}$: 3 and 45; $^{2}/_{9}$: 7 and 55 specimens.

Clupea sprattus L. In a couple of herring from $^{5}/_{8}$ 24, two post-larval stages (ca. 8 mm. long) were found, undoubtedly belonging to this species.

Fish eggs were never found in any great number in the stomach contents, but as they were occasionally present in a relatively large number of the herring (Table 63) they must be of some importance as an item of food.

Table 63. Monthly percentages of herring containing fish eggs. Rudkøbing.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	—	3.3 (1 : 30)	—
1924	x	x	x	26.3 (5 : 19)	12.5 (4 : 32)	52.9 (9 : 17)	7.4 (2 : 27)	—	7.1 (1 : 14)	37.5 (6 : 16)	—	—
1925	x	x	14.3 (1 : 7)	3.6 (1 : 28)	8.3 (3 : 36)	6.7 (1 : 15)	—	—	10.0 (1 : 10)	16.7 (1 : 6)	x	x
1926	37.5 (3 : 8)	8.1 (3 : 37)	x	37.5 (3 : 8)	x	x	x	x	x	x	x	x

The monthly average of fish eggs per herring varied from 1 to 12. Fish eggs found in the stomach contents were often rendered opaque by the action of the preserving liquid (formalin) and identification was thus extremely difficult. In several cases, however, the embryo was at an advanced stage of development, and this, together with size and general appearance, facilitated determination as regards a part of the material. The results of the investigation are as follows:

Pleuronectes sp. Eggs of pleuronectids — presumably *Pl. platessa* L. — were found in the stomach contents of herring from $^{31}/_{1}$ and $^{28}/_{2}$ 26. A single herring from the last-named sample contained 17 eggs, all undoubtedly those of plaice.

Clupea sp. By far the greater portion the eggs found in the stomach analyses were those of clupeoids, and an essential part of these again those of herring. They were frequently found assembled in the viscous film which envelopes the eggs.

Table 64. Occurrence of herring eggs as food in the various herring samples. Rudkøbing.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923									○ ○	○ ○	⊕ ○ ○	○ ○ ○
1924				⊕ ⊕	⊕ ○ ⊕	⊕ ⊕	○ ○ ○	○	○ ⊕ ○	○ ○ ⊕	○ ○ ○	○
1925			○ ○ ⊕	○ ○ ⊕	⊕ ○ ⊕	⊕ ○	○	○	○ ⊕	⊕		
1926	○ ○	○ ○		⊕								

It will be seen from Table 64 that herring eggs were found in the food at two distinct periods, viz. spring and autumn. In spring, herring eggs were found in the stomach contents from the end of March to mid-June, and in autumn, from mid-September to early November, which agrees with the spawning season for herring in these waters (see Table 9, p. 19). The greatest number of herring eggs found in a single herring stomach is 12. From the data here noted, it appears that herring not infrequently devour their own eggs; and further, that the fish themselves must then be moving close to the bottom, the eggs of the herring being, as we know, demersal. Both immature and mature herring have been found with herring eggs in the stomach; and both male and female feed on these eggs.

Vegetable Food.

It is only rarely that vegetable remains appear in the stomach contents of the herring. True, solitary diatoms and peridinians are not infrequently found; in most cases, however, the organisms in question were presumably not taken directly by the herring as food, but had already served as such for crustaceans, polychætes or other creatures, and, when these had been swallowed and digested by the herring, remained in the stomach. Only in two cases were diatoms found under circumstances suggesting that they had been taken directly by the herring as food. These were two fish from $^1/_8$ 25, which were found to contain 10—15 specimens respectively of *Coscinodiscus sp.*, these also constituting the only identifiable matter in the stomachs. Small remains of *Zostera* and algæ are occasionally met with, but as vegetable remains generally are only found in the very smallest quantities, we can hardly attribute any great importance to these few finds.

e. Concluding remarks on the food of the herring in Rudkøbing waters.

There is no time of year at which the herring takes food in a particular degree; the percentage of fish containing food is however, relatively low for the months of January and March, and, in autumn, for September and October. Mature herring are generally found to contain less food than those with the genital organs but slightly developed; we find however, that the mature spring-spawning herring in these waters feed to a far greater extent than do the autumn-spawning fish.

Crustaceous food was found on the average in 93.1 %, and non-crustaceous food in 25.2 % of the feeding herring examined. The following crustacea were found in the food of the herring: copepods, cladocerans, mysids, amphipods, isopods, cumacea, decapods and cirripede larvæ. Among non-crustacea were found: polychætes, gastropods, chætognaths, appendicularians, together with fish and fish eggs.

Copepods are, quantitatively, by far the most important organisms in the food, but are chiefly taken during the first six months of the year. The most important species is *Temora longicornis*, which amounts to 56.2 % of all copepods found in the stomach analyses; then come *Pseudocalanus elongatus* and *Paracalanus parvus* (together 34.2 %), *Centropages hamatus* (7.7 %) and the genus *Acartia* (1.6 %). Other copepods are of altogether subordinate importance as food. Cladocerans have only been found in the food from April to October, and only in relatively small quantities. The genera *Evadne* and *Podon* appear in about the same numbers. Mysids seem to enter into the food of the herring mainly during the latter half of the year, and were in one year (1923) exceptionally numerous in the stomach contents, in November and December. The relative quantities of the principal mysid species are as follows: *Gastrosaccus spinifer* 33.8 %, *Macromysis inermis* 30.8 %, *Macromysis flexuosa* 15.1 %, *Schistomysis spiritus* 10.0 % and *Macromysis neglecta* 9.5 %. Amphipods are found mainly during the latter half of the year. *Gammarus locusta* is by far the most important amphipod, amounting to 85.1 % of all amphipods. Isopods and cumacea likewise appear in the food of the herring chiefly during the last six months of the year, but are never found in any great number. With one exception, all the isopods taken belonged to the genus *Idothea*, and all the cumacea to the genus *Diastylis*. Cirripede larvæ and decapod larvæ are rarely found in any great quantity in the food. The former are mainly noted in spring, and the decapod larvæ only from May to November.

Among non-crustacea, the polychætes are — especially in the spring and summer months — of great importance as food for the herring in Rudkøbing waters; young stages of fish and fish eggs are also important items in the food. Fish are taken chiefly in summer and autumn, fish eggs on the other hand are noted in most months of the year. Of other organisms are found gastropod larvæ, chætognaths (*Sagitta*) and appendicularians (*Oikopleura*); these are, however, of quite subordinate importance as herring food.

Various organisms such as *Oikopleura, Sagitta, Cyphonautes* and larval molluscs are sometimes found to be common in the plankton, but are either not found at all, or appear only in the smallest quantity in the food of the herring.

2. The Sound and Køge Bugt.

a. Material.

Owing to the irregularity of the herring fishery in the Sound during recent years, it was impossible to procure samples from one and the same place at anything like definite intervals. The collections were therefore made at different places according to the progress of the fishery. The greater part of the herring were taken with stake nets in Svanemølle Bugt (depth 4—10 m.), a little to the north of Copenhagen, and along the coast up to Snekkersten. To these must be added a few samples taken in the northern part of Køge Bugt (see chart, p. 8). Furthermore, in June, July and August 1924 some samples of herring were taken from drift net catches in the water between Amager and Saltholm (depth 8—14 metres). The distance between the various localities from which the fish were procured being comparatively slight, the whole of the material has been dealt with together.

The total number of herring from the Sound and Køge Bugt which have been subjected to stomach analysis is 684, the numbers for the different months from 1923—1925 being as follows:

Table 65. Numbers of herring examined per month. The Sound and Køge Bugt.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923	—	—	—	—	—	—	—	—	59	—	52	—
1924	—	—	—	—	—	17	20	10	24	49	59	—
1925	22	—	26	19	—	—	—	46	107	111	63	—
Total	22	—	26	19	—	17	20	56	190	160	174	—

The table below shows the monthly number of herring of different lengths. The material from November 1923 is not included here, as in this month, owing to an oversight, the stomachs were removed on the spot, and we have consequently no record of the length, sex, etc. of the fish.

Table 66. Length and number of herring examined. The Sound and Køge Bugt.

cm.	Jan.	March	April	June	July	Aug.	Sept.	Oct.	Nov.	Total
16	1	..	..	..	..	..	1	2	1	5
17	2	..	..	..	..	1	2	22	12	39
18	3	1	2	..	..	6	18	25	19	74
19	1	1	2	..	1	4	19	28	18	74
20	3	3	2	1	4	6	25	19	19	82
21	1	2	2	7	6	6	39	19	17	99
22	2	6	5	7	6	9	32	19	10	96
23	5	6	3	2	3	7	19	18	13	76
24	2	6	3	..	..	9	12	6	8	46
25	2	1	..	..	..	4	7	1	3	18
26	..	..	..	..	..	..	7	..	2	9
27	..	..	..	..	..	2	7	..	..	9
28	..	..	..	..	..	2	1	1	..	4
29	..	..	..	..	..	..	..	..	..	..
30	..	..	..	..	..	..	1	..	..	1

The present material from the Sound and Køge Bugt contains very few mature fish, and no determination of maturity was therefore made in the case of samples from these waters.

b. The relative numbers of herring containing food in the different months.

Of all the herring investigated — numbering 684 — from the Sound and Køge Bugt, 419, or 61.3 %, had recognisable stomach contents. Investigation of the relative quantities of herring containing food in the different months gives the following result.

Table 67. Monthly percentages of herring containing food. The Sound and Køge Bugt.
(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined).

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	66.1 (39 : 59)	x	67.3 (35 : 52)	x
1924	x	x	x	x	x	94.1 (16 : 17)	100.0 (20 : 20)	80.0 (8 : 10)	45.8 (11 : 24)	49.0 (24 : 49)	52.5 (31 : 59)	x
1925	81.8 (18 : 22)	x	80.8 (21 : 26)	47.4 (9 : 19)	x	x	x	21.7 (10 : 46)	67.3 (72 : 107)	42.3 (47 : 111)	92.1 (58 : 63)	x

The percentage of herring containing food is remarkably high for the months of June, July and August 1924. The samples for these months were taken in drift nets, and consequently over greater depths than those from the remaining months, all of which were stake net herring. Unfortunately, we have no figures for stake net herring during these months, with the exception of August (1925) when only 21.7 % of the fish had food in the stomach, whereas the herring taken in drift nets during the same month (1924) showed 80 % with stomach contents. This suggests that herring taken over greater depths take more food than do those from shallower waters.

c. Brief survey of the composition of the food.

We shall here first consider the importance of crustaceous food as compared with the non-crustaceous elements, and thereafter, the proportion in which the various groups of organisms occur in the food.

Table 68. Monthly percentages of herring containing crustaceous and non-crustaceous food. The Sound and Køge Bugt.

		1923		1924						1925						
		Sept.	Nov.	June	July	Aug.	Sept.	Oct.	Nov.	Jan.	March	April	Aug.	Sept.	Oct.	Nov.
No. of feeding herring		39	35	16	20	8	11	24	31	18	21	9	10	72	47	58
Crustaceous food	No.	36	34	16	20	8	9	23	28	18	20	7	10	67	44	58
	%	92.3	97.1	100.0	100.0	100.0	81.8	95.8	90.3	100.0	95.2	77.8	100.0	93.1	93.6	100.0
Non-crustaceous food	No.	5	3	8	7	2	3	5	4	1	10	5	1	22	5	29
	%	12.8	8.6	50.0	35.0	25.0	27.3	20.8	12.9	5.6	47.6	55.6	10.0	30.6	10.6	50.0

As regards the herring in the Sound and Køge Bugt, crustaceans are by far the most important item in the food as compared with other organisms; this will be seen from Table 68. Calculating the average percentage of herring with crustacea and non-crustacea as food, we obtain the monthly result given below.

Table 69. Mean monthly percentage of herring with crustaceous and non-crustaceous food. The Sound and Køge Bugt, 1923—25.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Crustaceous food	100.0	x	95.2	77.8	x	100.0	100.0	100.0	89.1	94.7	95.8	x
Non-crustaceous food	5.6	x	47.6	55.6	x	50.0	35.0	17.5	23.6	15.7	23.8	x

During the months of March, April and June, non-crustaceous food was found in about half the herring with stomach contents examined; in the remaining months, non-crustaceous food was only found in a relatively smaller number. The mean value for all months for which figures are available shows

crustacea as food in 94.7 % and non-crustacea in 30.5 %. Table 70 shows the monthly percentages of herring in which the various groups of organisms were found in the food. The values arrived at are given graphically in Fig. 4, p. 48; cumacea, ostracods and lamellibranch larvæ however, are here omitted, all these being of altogether negligible significance.

Table 70. Monthly percentages of herring containing the various groups of organisms, calculated from the total number of feeding herring in the respective months. The Sound and Køge Bugt.

	1923		1924						1925						
	Sept.	Nov.	June	July	Aug.	Sept.	Oct.	Nov.	Jan.	March	April	Aug.	Sept.	Oct.	Nov.
Copepoda	79.5	71.4	100.0	100.0	100.0	63.6	83.3	71.0	100.0	90.5	66.7	10.0	65.3	48.9	98.3
Cladocera	7.7	—	50.0	35.0	25.0	9.1	45.8	12.9	—	4.8	11.1	80.0	55.6	19.1	3.4
Mysidacea	28.2	22.9	—	—	—	—	12.5	12.9	5.6	9.5	—	—	8.3	19.1	5.2
Amphipoda	25.6	2.9	6.2	—	—	—	8.3	16.1	5.6	19.0	—	—	12.5	12.8	5.2
Isopoda	12.8	—	—	—	—	—	8.3	12.9	5.6	4.8	—	20.0	13.9	42.6	6.9
Cirripedia	—	5.7	—	—	—	—	—	—	—	—	—	—	—	2.1	29.3
Decapoda	—	—	—	5.0	50.0	18.2	—	—	—	4.8	—	—	1.4	—	—
Cumacea	—	—	—	—	—	—	8.3	—	5.6	—	—	—	—	2.1	—
Ostracoda	—	—	6.2	—	—	—	—	—	—	—	11.1	—	—	—	—
Gastropoda	5.1	2.9	—	—	—	9.1	4.2	3.2	—	—	—	—	4.2	—	41.4
Lamellibranchiata	—	—	—	5.0	12.5	—	—	—	—	—	—	—	—	—	—
Chætognatha	—	—	6.2	—	12.5	9.1	16.7	—	—	—	—	—	11.1	—	12.1
Appendicularіæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	32.8
Pisces	7.7	5.7	—	—	—	9.1	—	9.7	5.6	—	—	10.0	16.7	4.3	1.7
Pisces ova	—	—	50.0	35.0	—	9.1	—	—	—	47.6	55.6	—	1.4	6.4	—

In nearly all months, it is the copepods which are found in the greatest number of herring. Cladocerans are numerous especially in summer and part of autumn; and during the latter half of the year especially we find mysids, amphipods and isopods in the stomach contents of a great number of herring. Cirripede larvæ are only noted in the food in October and November; decapods mainly in August and September.

As regards the non-crustacea, it is remarkable that polychætes are not found in the stomach contents of herring from the Sound and Køge Bugt. Gastropods and chætognaths are noted especially in autumn, and appendicularians are only found in the food in a single month, viz. November 1925. Fish appears in the food for January and August—November inclusive, but never in more than a small percentage of the stomach analyses. Fish eggs are particularly common in March, April, June and July; during the remaining months covered by the investigations they are either not found in the food at all, or in only a small number of herring. Calculating the monthly mean value from the data available, we obtain the result shown in Table 71, p. 49. Unfortunately, there are no investigations for the months of February, May and December; the material is however, sufficient to give an idea as to the occurrence of the organisms in the food of the herring at the different seasons of the year.

d. Systematic survey of the occurrence of the different organisms in the food.

In the following survey of the occurrence of the different organisms in the food of the herring, the organisms concerned are taken in their systematic order. As already mentioned, polychætes have not been found in the food of the herring from these waters. It may be due to accident that none such were found in the stomach contents, but there can hardly be any doubt that they are far less important as food for the herring in the Sound and Køge Bugt than in various other waters. The method of arrangement is precisely the same as that previously employed. For explanation of the tables see p. 11.

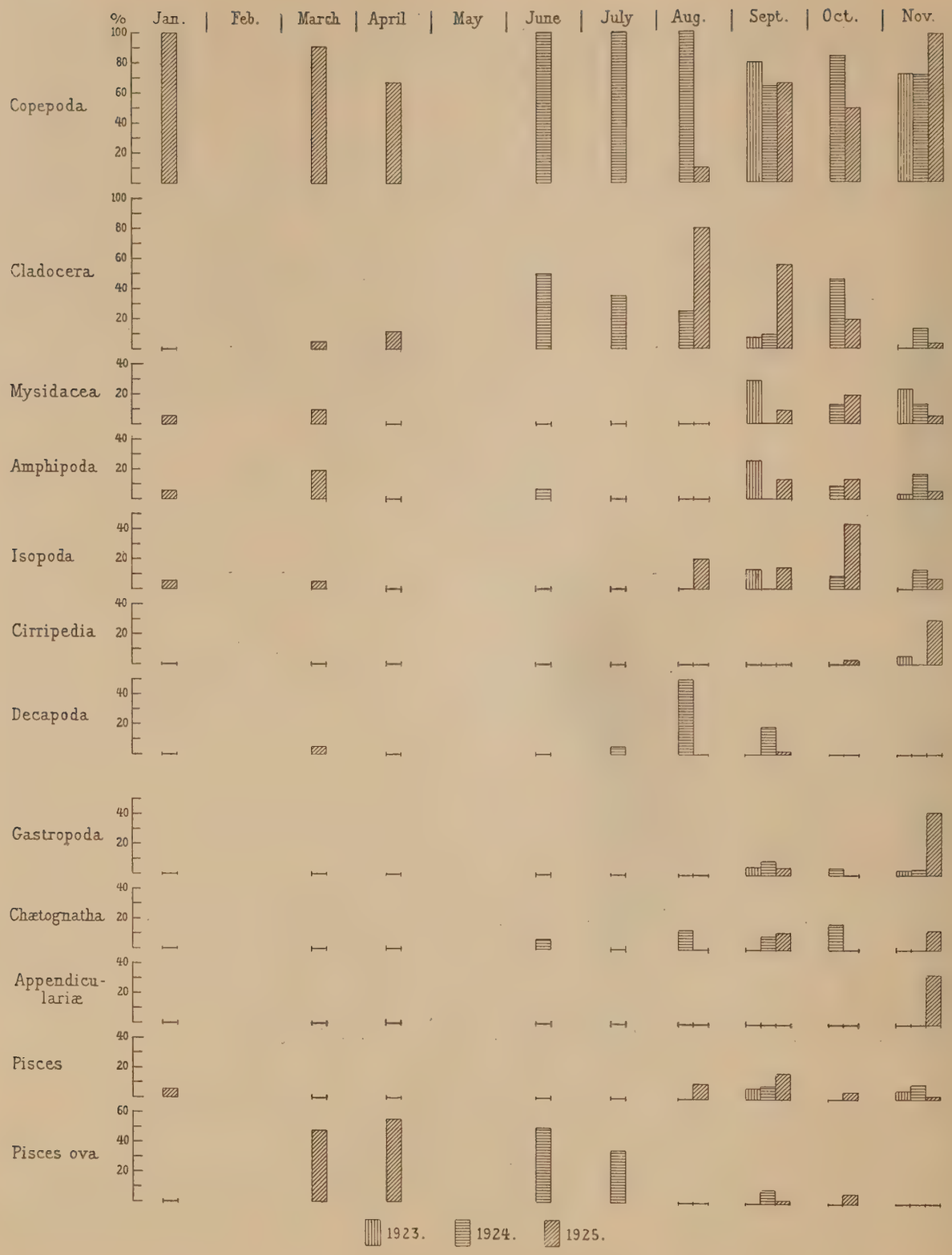


Fig. 4. Monthly percentages of herring stomachs containing the more important groups of organisms. The Sound and Køge Bugt.

Table 71. Mean monthly percentage of herring containing the different groups of organisms. The Sound and Køge Bugt.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Copepoda	100.0	x	90.5	66.7	x	100.0	100.0	55.0	69.5	66.1	80.2	x
Cladocera	—	x	4.8	11.1	x	50.0	35.0	52.5	24.1	32.4	5.4	x
Mysidacea	5.6	x	9.5	—	x	—	—	—	12.2	15.8	13.7	x
Amphipoda	5.6	x	19.0	—	x	6.2	—	—	12.7	10.5	8.1	x
Isopoda	5.6	x	4.8	—	x	—	—	10.0	8.9	25.4	6.6	x
Cirripedia	—	x	—	—	x	—	—	—	—	1.0	11.7	x
Decapoda	—	x	4.8	—	x	—	5.0	25.0	6.5	—	—	x
Cumacea	5.6	x	—	—	x	—	—	—	—	5.2	—	x
Ostracoda	—	x	—	11.1	x	6.2	—	—	—	—	—	x
Gastropoda	—	x	—	—	x	—	—	—	6.1	2.1	15.8	x
Lamellibranchiata	—	x	—	—	x	—	5.0	6.2	—	—	—	x
Chætognatha	—	x	—	—	x	6.2	—	6.2	6.7	8.8	4.0	x
Appendiculariæ	—	x	—	—	x	—	—	—	—	—	10.9	x
Pisces	5.6	x	—	—	x	—	—	5.0	11.2	2.1	5.7	x
Pisces ova	—	x	47.6	55.6	x	50.0	35.0	—	3.5	3.2	—	x

Cladocera.

During summer and autumn, cladocerans were found in the stomachs of a considerable number of herring. Table 72 shows the percentage of herring containing cladocerans in the months covered by the investigations.

Table 72. Monthly percentages of herring containing cladocerans. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	7.7 (3 : 39)	x	—	x
1924	x	x	x	x	x	50.0 (8 : 16)	35.0 (7 : 20)	25.0 (2 : 8)	9.1 (1 : 11)	45.8 (11 : 24)	12.9 (4 : 31)	x
1925	—	x	4.8 (1 : 21)	11.1 (1 : 9)	x	x	x	80.0 (8 : 10)	55.6 (40 : 72)	19.1 (9 : 47)	3.4 (2 : 58)	x

The highest percentages are found from June to October; it should be borne in mind, however, that there are no figures for May in any year. As will be seen from Table 73 the greatest numbers of cladocerans found in the food are from the autumn months.

Table 73. Average number of cladocerans, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	3 (8 : 3)	x	—	x
1924	x	x	x	x	x	3 (22 : 8)	2 (13 : 7)	1 (3 : 2)	6 (6 : 1)	28 (303 : 11)	2 (7 : 4)	x
1925	—	x	1 (1 : 1)	1 (1 : 1)	x	x	x	32 (256 : 8)	46 (1857 : 40)	7 (64 : 9)	1 (2 : 2)	x

The following species were found in the food of the herring from the Sound and Køge Bugt:

Bosmina maritima P. E. Müller
Evadne Nordmanni Lovén
Evadne spinifera P. E. Müller
Podon Leuckarti G. O. Sars
Podon intermedius Lillj.
Podon polyphemoides (Leuck.).

Bosmina maritima. This decidedly Baltic species was common in the food, especially in the autumn of 1925. In August of that year it appeared in 80 % of the positive stomach analyses; in September in 37.5 %, and in October in 6.4 %. The average numbers per herring in the three months were 32, 45 and 3 respectively. The averages are based on the following numbers of *Bosmina* and of herring containing such, for the three months in question: 255 : 8,

1203 : 27 and 8 : 3. In 1924, the species was only found as food in October, in two herring, the number of specimens being 17. The greatest number found in a single stomach was no less than 950 (Svanemølle Bugt $^{18}/_{9}$ 25). Table 74 shows that *Bosmina maritima* was only met with in the plankton samples during autumn.

Table 74. Bosmina maritima. Occurrence in plankton samples and in herring samples. The Sound and Køge Bugt.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									○ ○		○ ○	
	1924						○ ○	○ ○	○	⊗ ⊗	● ● ○	○ ○	
	1925	○		○	○				⊗	○ ● ●	⊗ ⊗ ○	○ ○	
Herring samples	1923									○ ○		○ ○	
	1924						○ ○	○ ○	○	○ ○	⊕ ○ ○	○ ○	
	1925	○		○	○				⊕	○ ⊕ ⊕	⊕ ⊕ ○	○ ○	

Evadne sp. As it was rarely possible to determine the species with certainty in the stomach analyses, the genus is here taken under one head. The monthly percentages of herring in which *Evadne* was found as food will be seen from Table 75.

Table 75. Monthly percentages of herring containing Evadne. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	7.7 (3 : 39)	x	—	x
1924	x	x	x	x	x	50.0 (8 : 16)	30.0 (6 : 20)	—	—	12.5 (3 : 24)	—	x
1925	—	x	4.8 (1 : 21)	—	x	x	x	10.0 (1 : 10)	40.3 (29 : 72)	17.0 (8 : 47)	—	x

It will be noticed that *Evadne* was especially common in the food during summer and early autumn. The monthly averages per herring for 1923 and 1924 were only 2—3 specimens, whereas in Sept. 1925 we have 22, and in Nov. of the same year 7. The high average for Sept. 1925 was due to the presence in a single herring stomach of no fewer than 550 specimens. A very large majority of the specimens found in the food belonged to the species *E. Nordmanni*. *E. spinifera* was only noted with certainty in two cases (Sept. 1925). This last-named species was only found in small numbers in the plankton samples for Sept. and Oct., whereas *E. Nordmanni* appeared in the plankton from the end of March to early November, as shown in Table 76.

Table 76. Occurrence of Evadne Nordmanni in plankton samples, and of the genus Evadne in herring samples. The Sound and Køge Bugt.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									● ○		○ ○	
	1924						● ●	● ⊗	●	⊗ ●	⊗ ● ○	⊗ ○	
	1925	○		⊗	⊗				●	⊗ ● ●	● ● ⊗	⊗ ○	
Herring samples	1923									⊕ ⊕		○ ○	
	1924						⊕ ⊕	⊕ ⊕	○	○ ○	⊕ ⊕ ○	○ ○	
	1925	○		⊕	○				⊕	⊕ ⊕ ⊕	⊕ ⊕ ⊕	○ ○	

Podon sp. Species of the genus *Podon* appeared, on the whole, in somewhat smaller numbers in the food than those of the genus last considered. In our present material, the largest numbers of herring containing *Podon* were found during the period August—October (Table 77).

In October 1924, the genus was unusually numerous in the food. A single fish was found to contain 240 specimens, and the average number of *Podon* per herring for this month was 28, the highest average for any other month being 3 per fish.

Table 77. Monthly percentages of herring containing Podon. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	x	—	x
1924	x	x	x	x	x	6.2 (1 : 16)	10.0 (2 : 20)	25.0 (2 : 8)	18.2 (2 : 11)	41.7 (10 : 24)	12.9 (4 : 31)	x
1925	—	x	—	11.1 (1 : 9)	x	x	x	—	13.9 (10 : 72)	2.1 (1 : 47)	3.4 (2 : 58)	x

In the stomach analyses, it was only possible in a very few cases to determine the species of the specimens found, and we cannot therefore say anything as to the quantitative occurrence of individual species. Three species were noted in the plankton samples: *Podon Leuckarti* and *P. intermedius* in greatest numbers, *P. polyphemoides* less common. A few specimens of this last-named species were taken from the end of August to early October; the two others appeared in the plankton samples as shown in Table 78.

Table 78. Occurrence of Podon Leuckarti and Podon intermedius in plankton samples, and of the genus Podon in herring samples. The Sound and Køge Bugt.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples:												
Podon Leuckarti 1923									⊗ ○		○ ○	
Podon Leuckarti 1924						○ ⊗	● ⊗	○	⊗ ●	⊗ ○ ○	○ ○	
Podon Leuckarti 1925	○		○	⊗				⊗	● ● ⊗	⊗ ⊗ ○	○ ○	
Podon intermedius 1923									● ⊗		○ ○	
Podon intermedius 1924						○ ●	⊗ ⊗	●	⊗ ●	● ⊗ ●	⊗ ⊗	
Podon intermedius 1925	○		○	⊗				⊗	⊗ ● ⊗	● ⊗ ○	⊗ ⊗	
Herring samples:												
Podon sp. 1923									○ ○		○ ○	
Podon sp. 1924						○ ⊕	⊕ ⊕	⊕	○ ⊕	⊕ ⊕ ⊕	⊕ ⊕	
Podon sp. 1925	○		○	⊕				○	⊕ ⊕ ⊕	○ ⊕ ○	⊕ ⊕	

Ostracoda.

On two occasions, $^{21}/_{6}$ 24 and $^{22}/_{4}$ 25, a single ostracod was found in the stomach of a herring. In both cases, the species was probably *Philomedes globosa* (Lillj.).

Copepoda.

Copepods were found in the food of a very great number of herring during all the months covered by the investigations, as will be seen from Table 79.

Table 79. Monthly percentages of herring containing copepods. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	79.5 (31 : 39)	x	71.4 (25 : 35)	x
1924	x	x	x	x	x	100.0 (16 : 16)	100.0 (20 : 20)	100.0 (8 : 8)	63.6 (7 : 11)	83.3 (20 : 24)	71.0 (22 : 31)	x
1925	100.0 (18 : 18)	x	90.5 (19 : 21)	66.7 (6 : 9)	x	x	x	10.0 (1 : 10)	65.3 (47 : 72)	48.9 (23 : 47)	98.3 (57 : 58)	x

All the feeding herring taken in June, July and August 1924 were found to contain copepods. These samples were taken from the drift net catches, and thus over greater depths than the remaining samples, which were stake net herring. This may perhaps explain the exceptional abundance of copepods in the herring in question. Calculating the average numbers of copepods per fish, we obtain for the different months, the figures shown below. (Table 80).

In most of the months covered by the investigations, the numbers of copepods found in the stomach contents were considerable. The lowest figures were those for August and September, the averages for the remaining months

Table 80. Average number of copepods, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	40 (1255 : 31)	x	1457 (36437 : 25)	x
1924	x	x	x	x	x	74 (1191 : 16)	145 (2897 : 20)	11 (86 : 8)	1 (10 : 7)	94 (1884 : 20)	97 (2141 : 22)	x
1925	80 (1432 : 18)	x	300 (5695 : 19)	100 (598 : 6)	x	x	x	4 (4 : 1)	11 (534 : 47)	14 (333 : 23)	81 (4595 : 57)	x

being as a rule far higher. In November 1923, the average number of copepods was conspicuously in excess of the usual, viz. 1457 specimens, the averages for the same month in 1924 and 1925 being only 97 and 81 respectively. Unfortunately, we have no investigations for December, but the results as they are, suggest that the herring of these waters feed largely on copepods during the winter months.

The following copepods were found in the food of herring from the Sound and Køge Bugt:

Calanus finmarchicus (Gunner.)
Pseudocalanus elongatus Boeck
Paracalanus parvus Claus
Centropages typicus Krøyer
Centropages hamatus (Lillj.)
Temora longicornis (O. F. Müller)
Eurytemora hirundo Giesbrecht
Labidocera Wollastoni Lubbock
Acartia longiremis (Lillj.)
Acartia bifilosa (Giesbrecht)
Oithona similis Claus
Microsetella norvegica (Boeck)
Caligus sp.

In the following survey, the species *Pseudocalanus elongatus* and *Paracalanus parvus* are taken together; the two species of the genus *Acartia* likewise, as it was found impossible to determine the species with certainty in the case of these copepods. Table 81 shows the relative importance of the various copepods as constituents in the food of the herring.

Table 81. Relative importance of the various copepods as food for the herring during the different months. The Sound and Køge Bugt.

	Jan.		March		April		June		July		Aug.		Sept.		Oct.		Nov.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Calanus finmarchicus	—	—	2	0.04	1	0.19	—	—	1	0.04	—	—	—	—	2	0.10	—	—
Pseudocal. + Paracalanus	38	3.87	1952	37.90	451	86.24	66	6.50	787	28.49	16	19.51	121	11.69	28	1.36	2892	10.29
Centropages typicus	—	—	—	—	—	—	—	—	—	—	—	—	2	0.19	—	—	3	0.01
Centropages hamatus	2	0.21	73	1.42	25	4.78	72	7.09	293	10.61	8	9.76	13	1.26	36	1.74	534	1.90
Temora longicornis	939	95.62	2811	54.58	2	0.38	704	69.29	1008	36.49	46	56.10	811	78.36	1851	89.68	9777	34.78
Eurytemora hirundo	—	—	—	—	—	—	—	—	2	0.07	—	—	—	—	17	0.82	—	—
Labidocera Wollastoni	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	<0.01
Acartia sp.	2	0.20	312	6.06	44	8.41	164	16.14	662	23.97	11	13.41	86	8.31	130	6.30	14900	53.01
Oithona similis	—	—	—	—	—	—	—	—	—	—	—	—	1	0.10	—	—	—	—
Harpacticidæ	1	0.10	—	—	—	—	10	0.98	9	0.33	1	1.22	—	—	—	—	2	0.01
Caligus sp.	—	—	—	—	—	—	—	—	—	—	—	—	1	0.09	—	—	—	—

In most of the months, *Temora longicornis* is numerically predominant. In April however, we find *Pseudocalanus* + *Paracalanus* as the most important copepods, and in November, the genus *Acartia* appears in the greatest numbers.

The total numbers of the different copepods, with the percentages of the whole, are given below:

Temora longicornis	17.949 spec.	43.020 %
Acartia sp.	16.311 —	39.094 —
Pseudocalanus + Paracalanus	6.351 —	15.222 —
Centropages hamatus	1.056 —	2.531 —
Harpacticidæ	23 —	0.055 —
Eurytemora hirundo	19 —	0.046 —
Calanus finmarchicus	6 —	0.014 —

Centropages typicus	5 spec.	0.012 %
Labidocera Wollastoni	1 —	0.002 —
Oithona similis	1 —	0.002 —
Caligus sp.	1 —	0.002 —

The most important copepods serving as food for the herring in these waters are thus: *Temora longicornis, Acartia sp., Pseudocalanus + Paracalanus,* and *Centropages hamatus,* the remaining species being practically negligible in this respect.

The foregoing calculations are naturally based only on those copepods which could be referred to definite species or at any rate, to their genus. A considerable proportion (ca. 25 %) however, of the copepods found in the food, proved unidentifiable. When the stomach is stuffed full of copepods, many of them are often unrecognisable, owing to the advanced state of dissolution.

With a view to gaining a further impression as to the food value of the different copepod species, we will first consider the relative numbers of herring in which these are found, calculated from the total number of feeding herring in the respective months.

Table 82. Monthly percentages of herring containing the different copepods. The Sound and Køge Bugt.

	1923		1924						1925						
	Sept.	Nov.	June	July	Aug.	Sept.	Oct.	Nov.	Jan.	Mar.	Apr.	Aug.	Sept.	Oct.	Nov.
Calanus finmarchicus	—	—	—	5.0	—	—	8.3	—	—	4.8	11.1				
Pseudocalanus + Paracalanus	17.9	57.1	68.7	90.0	37.5	36.4	37.5	32.3	38.9	81.0	66.7	—	43.1	10.6	75.9
Centropages typicus	—	—	—	—	—	—	—	—	—	—	—	—	2.8	—	5.2
Centropages hamatus	12.8	22.9	68.7	70.0	25.0	—	25.0	22.6	11.1	38.1	44.4	10.0	4.2	10.6	48.3
Temora longicornis	48.7	62.9	81.2	100.0	62.5	27.3	54.2	61.3	88.9	85.7	11.1	10.0	27.8	31.9	89.7
Eurytemora hirundo	—	—	—	10.0	—	—	8.3	—	—	—	—	—	—	—	—
Labidocera Wollastoni	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.7
Acartia sp.	33.3	57.1	87.5	85.0	50.0	9.1	50.0	61.3	5.6	52.4	55.6	—	13.9	31.9	77.6
Oithona similis	—	—	—	—	—	—	—	—	—	—	—	—	1.4	—	—
Harpacticidæ	—	—	37.5	35.0	12.5	—	—	—	5.6	—	—	—	—	—	3.4
Caligus sp.	—	—	—	—	—	—	—	—	—	—	—	—	1.4	—	—

It will be seen from the table above that the principal copepods already mentioned are found in the food of a great number of herring, but that we have, on the whole, the highest percentages in spring and summer, the autumn figures being comparatively low. In the winter months, the numbers seem to increase again, several of the copepods being found in a relatively large number of herring in November and January.

On considering the average numbers of the most important copepods per fish (Table 83), the variation in the importance of the copepods at the different seasons becomes even more pronounced.

Table 83. Monthly averages for the principal copepods, showing number of specimens per herring, containing the respective species. The Sound and Køge Bugt.

	1923		1924						1925						
	Sept.	Nov.	June	July	Aug.	Sept.	Oct.	Nov.	Jan.	Mar.	Apr.	Aug.	Sept.	Oct.	Nov.
Pseudocalanus + Paracalanus	4	115	6	44	5	1	2	4	5	115	75	—	3	2	13
Centropages hamatus	2	58	6	21	3	—	2	3	1	9	6	1	1	4	2
Temora longicornis	26	258	54	50	9	1	129	84	59	156	2	3	16	12	48
Acartia sp.	5	669	12	39	3	1	5	19	2	28	9	—	1	5	26

August and September show lower average figures in proportion than the remaining months for which any data are available. The great number of all copepods noted in Nov. 1923 is particularly striking.

Calanus finmarchicus. A few specimens of this species were found in the stomachs of herring from March, April, July and October. The greatest monthly number of herring containing this species amounts to 11.1 % of the

total of feeding herring examined (April 1925). *Calanus* has been found on only two occasions in the plankton samples, viz. $^{10}/_{10}$ 24 and $^{22}/_{4}$ 25.

Pseudocalanus elongatus and *Paracalanus parvus*. As already mentioned, these two species together constitute 15.2 % of all copepods. Table 84 shows the monthly percentages of herring containing the two species.

Table 84. Monthly percentages of herring containing Pseudocalanus + Paracalanus. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	17.9 (7 : 39)	x	57.1 (20 : 35)	x
1924	x	x	x	x	x	68.7 (11 : 16)	90.0 (18 : 20)	37.5 (3 : 8)	36.4 (4 : 11)	37.5 (9 : 24)	32.3 (10 : 31)	x
1925	38.9 (7 : 18)	x	81.0 (17 : 21)	66.7 (6 : 9)	x	x	x	—	43.1 (31 : 72)	10.6 (5 : 47)	75.9 (44: 58)	x

The highest percentages are those for the months of March, April, June and July, the lowest from August to October, and in January. November occupies an intermediate position, and varies greatly from one year to another. Table 85 shows the average number of specimens per herring for the different months.

Table 85. Average number of Pseudocalanus + Paracalanus, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	4 (25 : 7)	x	115 (2299 : 20)	x
1924	x	x	x	x	x	6 (66 : 11)	44 (787 : 18)	5 (16 : 3)	1 (5 : 4)	2 (19 : 9)	4 (36 : 10)	x
1925	5 (38 : 7)	x	115 (1952 : 17)	75 (451 : 6)	x	x	x	—	3 (91 : 31)	2 (9 : 5)	13 (557 : 44)	x

The greatest numbers appear in March and April, and, in the case of one year, (1923) in November. The average figures for Nov. 1924 and 1925 are far lower. In Aug., Sept. and October, these copepods are taken only in small numbers as food.

Examination of the occurrence of the two species in the plankton samples shows that *Pseudocalanus* is by far the more numerous in spring, and to some extent also in winter, *Paracalanus* having its maximum period in autumn (Table 86).

Table 86. Pseudocalanus elongatus and Paracalanus parvus. Occurrence in plankton samples and in herring samples. The Sound and Køge Bugt.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples:												
Pseudocalanus elongatus 1923									⊗ ●		● ●	
Pseudocalanus elongatus 1924						⊗ ●	⊗ ●	⊗	⊗ ⊗	⊗ ⊗ ●	⊗ ●	
Pseudocalanus elongatus 1925	●		●	●				⊗	⊗ ⊗ ⊗	⊗ ⊗ ●	⊗ ⊗	
Paracalanus parvus 1923									● ⊗		⊗ ⊗	
Paracalanus parvus 1924						○ ⊗	⊗ ●	●	● ●	● ● ⊗	⊗ ○	
Paracalanus parvus 1925	○		○	⊗				●	● ⊗ ●	● ● ⊗	● ⊗	
Herring samples:												
Pseudocal. + Paracalanus 1923									⊕ ⊕		⊕ ⊕	
Pseudocal. + Paracalanus 1924						⊕ ⊕	⊕ ⊕	⊕	⊕ ⊕	⊕ ⊕ ⊕	⊕ ⊕	
Pseudocal. + Paracalanus 1925	⊕		⊕	⊕				○	⊕ ⊕ ⊕	⊕ ⊕ ⊕	⊕ ⊕	

There is no doubt that *Pseudocalanus* is by far the more important as food for the herring in these waters, as the maximum period for *Paracalanus* falls in just those months (Aug.—Oct.) when *Pseudocalanus* + *Paracalanus* appear in very small numbers in the food.

Centropages typicus was found twice in the stomach analyses (4/9 and 6/11 25), only 5 specimens in all. The plankton samples yielded but a single specimen (7/10 25).

Centropages hamatus is, in contrast to the foregoing species, generally common in the plankton, as also in the stomach contents of the herring; it is however, of relatively slight importance as food (2.5 % of all copepods). It is found especially in June and July in a considerable number of herring (Table 87).

Table 87. Monthly percentages of herring containing Centropages hamatus. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	12.8 (5 : 39)	x	22.9 (8 : 35)	x
1924	x	x	x	x	x	68.7 (11 : 16)	70.0 (14 : 20)	25.0 (2 : 8)	—	25.0 (6 : 24)	22.6 (7 : 31)	x
1925	11.1 (2 : 18)	x	38.1 (8 : 21)	44.4 (4 : 9)	x	x	x	10.0 (1 : 10)	4.2 (3 : 72)	10.6 (5 : 47)	48.3 (28 : 58)	x

Taking the average number of specimens per herring for the different months (Table 88) it is clearly apparent that this species also was uncommonly abundant in the food in Nov. 1923.

Table 88. Average number of Centropages hamatus, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	2 (10 : 5)	x	58 (461 : 8)	x
1924	x	x	x	x	x	6 (72 : 11)	21 (293 : 14)	3 (7 : 2)	—	2 (14 : 6)	3 (22 : 7)	x
1925	1 (2 : 2)	x	9 (73 : 8)	6 (25 : 4)	x	x	x	1 (1 : 1)	1 (3 : 3)	4 (22 : 5)	2 (51 : 28)	x

The species was found in the plankton samples for all those months in which collections were made; it seems, however, to be common especially during the warmer season (Table 89). It is worth noting that in Nov. 1923, when it appeared in such great numbers in the stomach contents of the herring, only small numbers were noted in the plankton samples.

Table 89. Centropages hamatus. Occurrence in plankton samples and in herring samples. The Sound and Køge Bugt.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									● ⊗		⊗ ⊗	
	1924						● ●	● ●	●	⊗ ●	⊗ ⊗ ⊗	⊗ ⊗	
	1925	⊗		●	●				⊗	○ ● ●	● ⊗ ⊗	⊗ ⊗	
Herring samples	1923									⊕ ⊕		⊕ ⊕	
	1924						⊕ ⊕	⊕ ⊕	⊕	○ ○	⊕ ⊕ ⊕	⊕ ⊕	
	1925	⊕		⊕	⊕				⊕	○ ⊕ ⊕	⊕ ⊕ ○	⊕ ⊕	

Temora longicornis. In the Sound and Køge Bugt, this species is the commonest of all copepods in the herring food (43.0 % of all copepods).

Table 90. Monthly percentages of herring containing Temora longicornis. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	48.7 (19 : 39)	x	62.9 (22 : 35)	x
1924	x	x	x	x	x	81.2 (13 : 16)	100.0 (20 : 20)	62.5 (5 : 8)	27.8 (3 : 11)	54.2 (13 : 24)	61.3 (19 : 31)	x
1925	88.9 (16 : 18)	x	85.7 (18 : 21)	11.1 (1 : 9)	x	x	x	10.0 (1 : 10)	27.8 (20 : 72)	31.9 (15 : 47)	89.7 (52 : 58)	x

From August to October, the percentage values are low on the whole, but in most of the remaining months, *Temora* is found in a considerable number of herring. The high percentage in January is peculiar to this species, practically all other copepods being found in but a very small number of herring during this winter month. In Nov. 1923, we have the highest number on record, for a single fish, viz. 1520 specimens. The average numbers per fish are given in Table 91.

Table 91. Average number of Temora longicornis, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	26 (487 : 19)	x	258 (5666 : 22)	x
1924	x	x	x	x	x	54 (704 : 13)	50 (1008 : 20)	9 (43 : 5)	1 (3 : 3)	129 (1672 : 13)	84 (1597 : 19)	x
1925	59 (939 : 16)	x	156 (2811 : 18)	2 (2 : 1)	x	x	x	3 (3 : 1)	16 (321 : 20)	12 (179 : 15)	48 (2514 : 52)	x

The occurrence of *Temora* in the plankton samples (Table 92) shows that it was found on the whole in smaller numbers in the plankton during the autumn months, when relatively small numbers were found in the food (Aug.—Sept.). In November, on the other hand, when the average number found in the stomach contents was fairly high for all three years, the occurrence of the species is noted as common.

Table 92. Temora longicornis. Occurrence in plankton samples and in herring samples. The Sound and Køge Bugt.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923									● ●		● ●	
	1924						⊗ ●	● ●	●	⊗ ⊗	⊗ ● ●	● ●	
	1925	●		●	⊗				⊗	⊗ ● ⊗	⊗ ● ●	● ●	
Herring samples	1923									⊕ ⊕		⊕ ⊕	
	1924						⊕ ⊕	⊕ ⊕	⊕	⊕ ⊕	⊕ ⊕ ⊕	⊕ ⊕	
	1925	⊕		⊕	⊕				⊕	⊕ ⊕ ⊕	⊕ ⊕ ⊕	⊕ ⊕	

Eurytemora hirundo. This species, which is a pronounced Baltic form, was found only in very small numbers in the food (19 specimens in all). It was noted in the stomach contents of 4 herring from July and October 1924. In the plankton samples also, it was only recorded in the summer and autumn of 1924, and only in very small numbers.

Labidocera Wollastoni. A single specimen of this species was found in the stomach of a herring from Snekkersten, in the northern part of the Sound ($^6/_{11}$ 25). As far as we know, this is the first time this species has been found so far south in our inner waters; it is known from the Skagerrak and northern Kattegat.

Acartia sp. Out of the total number of copepods found in the stomach analyses, *Acartia* amount to 39.09 %, and thus come next to *Temora* as the most important copepod.

Table 93. Monthly percentages of herring containing Acartia. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	33.3 (13 : 39)	x	57.1 (20 : 35)	x
1924	x	x	x	x	x	87.5 (14 : 16)	85.0 (17 : 20)	50.0 (4 : 8)	9.1 (1 : 11)	50.0 (12 : 24)	61.3 (19 : 31)	x
1925	5.6 (1 : 18)	x	52.4 (11 : 21)	55.6 (5 : 9)	x	x	x	—	13.9 (10 : 72)	31.9 (15 : 47)	77.6 (45 : 58)	x

As in the case of several other copepods, *Acartia* are found in a relatively small number of the herring from Aug., Sept. and October. In November, the number of herring containing these copepods is considerable (57.1—77.6 %), whereas the figure for January is very low (5.6 %). The average for the number of *Acartia* per herring is lowest in the autumn months above noted, and in January (Table 94).

Table 94. Average number of Acartia, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	5 (70 : 13)	x	669 (13390 : 20)	x
1924	x	x	x	x	x	12 (164 : 14)	39 (662 : 17)	3 (11 : 4)	1 (1 : 1)	5 (62 : 12)	19 (361 : 19)	x
1925	2 (2 : 1)	x	28 (312 : 11)	9 (44 : 5)	x	x	x	—	1 (15 : 10)	5 (68 : 15)	26 (1149 : 45)	x

The altogether exceptionally large number of *Acartia* recorded in Nov. 1923 is hard to explain, but, as previously noted, unusually large numbers of copepods generally were found in the food during this month.

The only species identified with certainty in the stomach analyses are *Acartia longiremis* and *A. bifilosa*. Both were common in the plankton samples in which, also, a few specimens of *A. discaudata* (Giesbr.) were noted on three occasions viz. $^{2}/_{9}$ 24 and $^{28}/_{8}$ and $^{4}/_{9}$ 25. *Acartia bifilosa* was the more numerous in the plankton samples. It was also common during the summer months, when *A. longiremis* was only found in small numbers. (Table 95).

Table 95. Acartia longiremis and Acartia bifilosa. Occurrence in plankton samples. The Sound and Køge Bugt.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Acartia longiremis	1923									● ⊗		● ●	
	1924						⊗ ⊗	○ ○	⊗	⊗ ⊗	⊗ ⊗ ⊗	⊗ ●	
	1925	⊗		●	●				⊗	⊗ ⊗ ○	○ ● ⊗	⊗ ●	
Acartia bifilosa	1923									⊗ ●		⊗ ●	
	1924						● ●	● ●	●	⊗ ○	⊗ ● ⊗	● ●	
	1925	●		●	⊗				⊗	● ⊗ ●	● ● ●	● ●	

Oithona similis. Only a single specimen of this species was found in the food, viz. on the $^{4}/_{9}$ 25. The species was noted in most of the plankton samples, but as a rule only in small numbers.

Harpacticidæ. Analysis of the stomach contents of herring from these waters yielded altogether 23 harpacticids. In June and July 1924, they appeared in the stomach contents of a relatively large number of the fish (37.5 % and 35.0 % respectively), but only single specimens in each case. The few specimens which it was possible to identify all belonged to the species *Microsetella norvegica.* This species was noted on a single occasion in the plankton samples ($^{21}/_{6}$ 24).

Caligus sp. A specimen of this genus was found in the stomach of a herring from $^{4}/_{9}$ 25.

Cirripedia.

Larval stages of cirripedes were only found in the food in three months, viz. Nov. 1923 and Oct. and Nov. 1925. The herring containing cirripede larvæ amounted to 5.7, 2.1 and 29.3 % of all feeding herring in the respective months. There were two samples from Nov. 1925, viz. one $^{6}/_{11}$ from the northern part of the Sound (Snekkersten), and $^{21}/_{11}$ from Køge Bugt. In the latter sample, no cirripede larvæ were found in the stomach contents. In the former, comprising 33 fish, of which 30 had food in the stomach, 17, or 56.7 %, contained cirripede larvæ, these numbering 41 in all (see Tables VII—VIII, p. 137). In the two plankton samples for Nov. 1925, cirripede larvæ were only found in the one from the northern part of the Sound, and then in relatively large numbers. This agrees with the facts noted above.

Mysidacea.

Mysids appeared in the food especially in the months of Sept., Oct. and November (Table 96).

It will be noticed that mysids were not found in the food during the months of April, June, July and August. On glancing at the averages for number of mysids per fish containing such (Table 97), we see that the greatest numbers were found in the month of November.

Table 96. Monthly percentages of herring containing mysids. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	28.2 (11 : 39)	x	22.9 (8 : 35)	x
1924	x	x	x	x	x	—	—	—	—	12.5 (3 : 24)	12.9 (4 : 31)	x
1925	5.6 (1 : 18)	x	9.5 (2 : 21)	—	x	x	x	—	8.3 (6 : 72)	19.1 (9 : 47)	5.2 (3 : 58)	x

Table 97. Average number of mysids, per herring containing such, for the different months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	6 (70 : 11)	x	13 (108 : 8)	x
1924	x	x	x	x	x	—	—	—	—	1 (3 : 3)	16 (66 : 4)	x
1925	8 (8 : 1)	x	1 (2 : 2)	—	x	x	x	—	3 (16 : 6)	2 (21 : 9)	2 (5 : 3)	x

The number of mysids of which the species could be identified, amounted in all to 230, the respective numbers and percentages being as follows:

Gastrosaccus spinifer (Goës)	63 spec.	27.4 %
Macromysis neglecta (G. O. Sars)	54 —	23.5 —
Michtheimysis mixta (Lillj.)	53 —	23.0 —
Macromysis flexuosa (O. F. Müller)	26 —	11.3 —
Macromysis inermis (Rathke)	23 —	10.0 —
Macropsis Slabberi (v. Bened.)	6 —	2.6 —
Leptomysis gracilis (G. O. Sars)	2 —	0.9 —
Neomysis vulgaris (I. V. Thompson)	2 —	0.9 —
Schistomysis ornata (G. O. Sars)	1 —	0.4 —

Gastrosaccus spinifer was the species most frequently found in the food. It appeared only during the months of Sept., Oct. and November. The greatest number of herring containing this species fell in Oct. 1925 (14.9 %) and the greatest number of individuals found in a single stomach was 27.

Leptomysis gracilis. This species was hitherto only recorded for Danish waters, from the Skagerrak and Kattegat (Hansen 1910, p. 251; Stephensen 1910, p. 139; Björck 1915, p. 47). In the present investigations, two specimens were found in the stomach of a herring caught in Svanemølle Bugt, near Copenhagen ($^{27}/_{1}$ 25)[1]).

Macropsis Slabberi. A few specimens were found in the food (Nov. 1923, Jan. 1925).

Macromysis inermis. This species was found only in the stomach of a few herring from Sept. 1923 and March 1925. One herring taken in the former month contained 18 specimens.

Macromysis flexuosa. This species was only found in the food in autumn, and never in great numbers. The greatest number found in a single fish was 8.

Macromysis neglecta was found in the stomachs of two herring from Nov. 1924, in quite considerable numbers, viz. 6 and 48 specimens respectively.

Schistomysis ornata. A single specimen was noted in a herring from Oct. 1924.

Michtheimysis mixta. Considerable numbers of this form were found in some of the herring. The numbers per fish in the samples in which it was present were as follows: $^{7}/_{9}$ 1923 1, 1 and 5, $^{15}/_{11}$ 1923 15 and 30, and $^{27}/_{1}$ 1925, 1.

Neomysis vulgaris. Two specimens were found in a herring from Nov. 1924.

Decapoda.

The only adult specimen of a decapod found in the food was a *Crangon vulgaris* Fabr. taken from the stomach of a herring in March 1925. Apart from a few crab larvæ, *Carcinus mænas* (L.), from $^{4}/_{9}$ 25, the remaining decapod

[1]) As the specimens differed slightly in some respects from the usual description of the species, they were submitted to Professor W. M. Tattersall, of Cardiff, who kindly confirmed the identification.

larvæ, as far as they could be identified at all, were those of *Crangon*. These were noted in July, August and September 1924 in the stomachs of 5.0, 50.0 and 18.2 % respectively of the herring examined. The greatest number found in a single fish was 12.

Cumacea.

Cumacea were only found in the stomach contents of four out of all the herring examined. The total number of individuals was 11, only one species of which could be determined with certainty, viz. *Diastylis Rathkei* (Krøyer).

Isopoda.

All the isopods found in the food belonged to the genus *Idothea*. These appeared in the food in most of the months covered by the investigations, but seemed to be most important in the autumn (Table 98).

Table 98. Monthly percentages of herring containing Idothea. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	12.8 (5 : 39)	x	—	x
1924	x	x	x	x	x	—	—	—	—	8.3 (2 : 24)	12.9 (4 : 31)	x
1925	5.6 (1 : 18)	x	4.8 (1 : 21)	—	x	x	x	20.0 (2 : 10)	13.9 (10 : 72)	42.6 (20 : 47)	6.9 (4 : 58)	x

The average number of *Idothea* per herring for the different months did not exceed 3, but a single herring from Oct. 1925 was found to contain a greater number of this genus, to wit, 22 specimens. The species *Idothea baltica* (Pallas) and *Idothea viridis* (Slabber) were identified in the stomach analyses. The former was the more numerous, but as many of the specimens were young ones, precise determination of species was not always possible.

Amphipoda.

In autumn and winter, amphipods were not infrequently found in the food, as will be seen from Table 99.

Table 99. Monthly percentages of herring containing amphipods. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	25.6 (10 : 39)	x	2.9 (1 : 35)	x
1924	x	x	x	x	x	6.2 (1 : 16)	—	—	—	8.3 (2 : 24)	16.1 (5 : 31)	x
1925	5.6 (1 : 18)	x	19.0 (4 : 21)	—	x	x	x	—	12.5 (9 : 72)	12.8 (6 : 47)	5.2 (3 : 58)	x

A single herring from March 1925 had 30 amphipods in the stomach; the average per fish for this month was therefore rather high (10); in the remaining months, it did not exceed 4 specimens per fish.

Altogether 131 amphipods were found in the stomach contents, of which 123 specimens could be referred to their species or genus. The numbers and percentages were as follows:

Gammarus locusta L.	105 spec.	85.4 %
Calliopius Rathkei (Zaddach)	15 —	12.2 —
Bathyporeia sp.	1 —	0.8 —
Melita palmata (Mont.)	1 —	0.8 —
Corophium volutator (Pallas)	1 —	0.8 —

Bathyporeia sp. A single specimen of this genus was found in Sept. 1923.

Calliopius Rathkei. This was, next to *Gammarus locusta*, the most numerous of the amphipods found in the stomach analyses. The species was only found in a single sample, viz. % 23, four fish containing together 15 specimens.

Gammarus locusta was by far the commonest amphipod in the food of herring from these waters. It was found in all the months covered by the investigations, with the exception of April, July and August. The 30 amphipods previously noted as found in a single fish from March 1925 all belonged to this species; otherwise, the number of *Gammarus* per herring varied from 1 to 8.

Melita palmata. A specimen of this species was found in Sept. 1923.

Corophium volutator. A single specimen was noted in a herring from Sept. 1925.

Gastropoda.

Larval stages of gastropods appeared in the stomach contents only in the months of Sept., Oct. and November.

Table 100. Monthly percentages of herring containing larval gastropods. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	5.1 (2 : 39)	x	2.9 (1 : 35)	x
1924	x	x	x	x	x	—	—	—	9.1 (1 : 11)	4.2 (1 : 24)	3.2 (1 : 31)	x
1925	—	x	—	—	x	x	x	—	4.2 (3 : 72)	—	41.4 (24 : 58)	x

In Nov. 1925, larval gastropods were found in the food of a remarkably large number of the herring examined. Closer investigation however shows that only in one of the two herring samples for this month were gastropods found in the stomach contents (see Tables VII—VIII, p, 137). In the sample from Snekkersten (6/11) gastropod larvæ were found in 24 out of 30 herring, i. e. 80 %, whereas the herring from Køge Bugt (21/11) contained no gastropods at all. Similarly, the plankton samples from the two localities showed gastropod larvæ as common off Snekkersten, but lacking in Køge Bugt. The occurrence of the gastropod larvæ in the plankton samples, and their occurrence in the food of the herring will be seen from Table 101.

Table 101. Occurrence of larval gastropods in plankton samples and in herring samples. The Sound and Køge Bugt.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plankton samples	1923						○⊗	⊗⊗	●	○⊗		○○	
	1924									● ●	●⊗●	⊗○	
	1925	○		○	○				⊗	● ●⊗	⊗⊗⊗	● ○	
Herring samples	1923									⊕○		⊕○	
	1924						○○	○○	○	⊕ ○	○○⊕	⊕○	
	1925	○		○	○				○	⊕⊕⊕	○○○	⊕ ○	

Lamellibranchiata.

Lamellibranch larvæ were only of the very slightest importance as food: only in July and Aug. 1924 were a few larval stages found in the stomach analyses.

Chætognatha.

The number of herring in which *Sagitta* was noted as food is comparatively small (Table 102).

Table 102. Monthly percentages of herring containing Sagitta. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	x	—	x
1924	x	x	x	x	x	6.2 (1 : 16)	—	12.5 (1 : 8)	9.1 (1 : 11)	16.7 (4 : 24)	—	x
1925	—	x	—	—	x	x	x	—	11.1 (8 : 72)	—	12.1 (7 : 58)	x

Two herring taken on the 4/9 25, contained 30 and 50 specimens respectively; otherwise, the greatest number found in a single fish was 5. *Sagitta* occurred, as will be seen from Table 103, in great numbers in the plankton in autumn.

Appendiculariæ.

Among appendicularians, *Oikopleura dioica* Fol. was noted in the stomach contents of a single sample of herring from the Sound, 6/11 25. Out of 30 fish with definite stomach contents, 19, or 63.3 %, contained specimens of

Table 103. Sagitta. Occurrence in plankton samples. The Sound and Køge Bugt.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923									⊗⊗		○○	
1924						⊗⊗	⊗⊗	●	● ●	● ⊗ ●	○○	
1925	○		○	○				●	● ● ⊗	⊗ ● ⊗	●	○

this species, the average number being 9 per fish (see Table VII, p. 137). In the plankton samples, *Oikopleura* was noted during the months of Sept., Oct. and November, several times in considerable numbers.

Table 104. Oikopleura dioica. Occurrence in plankton samples. The Sound and Køge Bugt.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1923									○⊗		○	
1924						○○	○○	○	⊗ ●	⊗○ ●		
1925	○		○	○				○	○⊗⊗	○⊗○	●	

Pisces.

Fish appeared only in small quantity among the food of the herring from the Sound and Køge Bugt; fish eggs, however, were found at times in considerable numbers. The monthly percentages of herring containing fish are noted in the following table.

Table 105. Monthly percentages of herring containing fish. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	7.7 (3 : 39)	x	5.7 (2 : 35)	x
1924	x	x	x	x	x	—	—	—	9.1 (1 : 11)	—	9.7 (3 : 31)	x
1925	5.6 (1 : 18)	x	—	—	x	x	x	10.0 (1 : 10)	16.7 (12 : 72)	4.3 (2 : 47)	1.7 (1 : 58)	x

Fish appeared in the food of most of the autumn samples, but only in a small proportion of the herring examined. The greatest number found in a single stomach was 3. In the great majority of cases, indeterminable fish remains were found in the food. It was possible to identify with certainty young *Ammodytes sp.*, and *Clupea sprattus* L. *Ammodytes* were found in the food mostly in September, the specimens being invariably young stages (4—6 cm. long). A few sprats (6—7 cm. long) were found in two herring caught on the $^1/_{10}$ 25.

The monthly percentages of herring containing fish eggs will be seen from the table below.

Table 106. Monthly percentages of herring containing fish eggs. The Sound and Køge Bugt.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1923	x	x	x	x	x	x	x	x	—	x	—	x
1924	x	x	x	x	x	50.0 (8 : 16)	35.0 (7 : 20)	—	9.1 (1 : 11)	—	—	x
1925	—	x	47.6 (10 : 21)	55.6 (5 : 9)	x	x	x	—	1.4 (1 : 72)	6.4 (3 : 47)	—	x

During the months of March, April, June and July, fish eggs were found in a considerable number of herring; the average number of fish eggs per herring for these months varied from 3 to 15. A very great number of the fish eggs found in the stomach contents were unidentifiable. In March and April, eggs of pleuronectids especially were found, and in June and July, in addition to these, there were also, eggs, presumably of the sprat, together with a quantity of smaller eggs which could not be identified.

Vegetable Food.

A few fragments of plants have been found, quite exceptionally, among the food, but such can probably be regarded as taken as mere casual additions to the ordinary diet.

e. Concluding remarks on the food of the herring in the Sound and Køge Bugt.

Crustaceans are by far the most important item in the food of the herring in these waters. They appear on an average in the stomachs of 94.7 % of such fish as were found to contain any food at all, the average for non-crustacea being 30.5. The most important crustacea are copepods, cladocerans, mysids, amphipods and isopods; other forms, such as cirripede larvæ, decapod larvæ, cumacea and ostracods are of quite subordinate importance. Among non-crustaceous food may be noted especially fish eggs, fish, gastropod larvæ and chætognaths; appendicularians and lamellibranch larvæ are however, also found. Polychætes are not observed in the food of the herring from these waters.

The copepods are the most numerous of all organisms in the food. They appear in the stomachs of a great number of herring in nearly all the months covered by the investigations, but are relatively less important in the autumn. The principal copepods are *Temora longicornis* and *Acartia sp.*, which amount to about 43.0 and 39.1 % respectively of all copepods found in the stomach analyses. In most months, however, *Temora* is the more numerous. The two species *Pseudocalanus elongatus* + *Paracalanus parvus* are likewise common in the food (15.2 % of all copepods); *Centropages hamatus* on the other hand amounts to only 2.5 % of the copepods, the figures for the remaining forms being very low indeed. Cladocerans are found, especially in summer and autumn, in quite considerable numbers in the food. The commonest are species of the genera *Evadne* and *Podon*; in one year, however, the genus *Bosmina* was numerous in the autumn. Mysids are chiefly observed in the months of Sept., Oct. and November. The three following species occur in approximately equal numbers: *Gastrosaccus spinifer, Macromysis neglecta* and *Michtheimysis mixta* (23.0—27.4 % of all mysids), the other mysid forms being of comparatively slight importance. Of the amphipods, *Gammarus locusta* is by far the commonest species (85.4 % of all amphipods); it appears in the food at different seasons, but seems to be chiefly taken in autumn and winter. The same applies to the isopods, of which only the genus *Idothea* is observed in the stomach analyses. Decapod larvæ are found mostly in summer, and cirripede larvæ only in October and November. Cumacea and ostracods are apparently only exceptionally taken as food by the herring.

Among non-crustaceans, fish eggs and fish are of considerable importance in the diet. The former are noted especially in spring and summer; fish chiefly in autumn and winter. Larval gastropods and chætognaths, both of subordinate importance, appear mostly in autumn. Appendicularians (*Oikopleura*) are only observed in November, and lamellibranch larvæ in July—August.

3. Samsø.

a. Material.

Herring fishery with stake nets from Samsø falls into two distinct periods, a spring fishery and an autumn fishery. The spring fishery, commencing as a rule in the first half of April and terminating at the end of May or in the first half of June, generally gives a considerably better yield than the autumn fishery, which opens at the beginning of September and lasts until the beginning or middle of November. The winter of 1924—25 being very mild, a single stake net was set out tentatively in the middle of February, but after it had been out for a fortnight, and only a very few herring were caught, it was taken in again. Another attempt was made in the middle of March, but likewise without result, and it was not until the 6th of April that any considerable number of herring were taken. This seems to indicate that the herring, even in mild winters, do not appear in these waters in spring until April. The samples investigated were taken in stake nets in 4—9 metres of water, at Staalhøjshage, Besserrev, and in Nordby Bugt, all situate near the north-eastern corner of the island.

Herring samples and plankton samples were taken, as far as possible, at intervals of ten days. In the following tables therefore, the months are divided into three sections, answering to the samples taken respectively in the first, second and third part of the month. In several cases also, calculations have been based on the total material of herring taken in spring or autumn respectively during the different years.

The investigations represent the spring fishery in 1924 and 1925, and the autumn fishery in 1923, 1924 and 1925. The total number of herring examined from Samsø is 639, of which 236 are from the spring and 403 from the autumn fishery. The numbers of fish for the respective samples will be seen from Table 107.

Table 107. Numbers of herring examined in the different samples from Samsø.

	April			May			June			Sept.			Oct.			Nov.		
1923.....	x	x	x	x	x	x	x	x	x	x	20	20	20	20	20	20	20	x
1924.....	x	x	16	20	21	28	20	x	x	x	22	20	20	20	20	x	x	x
1925.....	20	21	20	25	25	20	x	x	x	x	26	22	22	25	36	30	x	x

Table 108 shows the total lengths of the herring examined, from which it will be seen that most were from 17—28 cm. There is however, a small sample of young herring from May (13—15 cm.). The former group will be referred to in the following as "adult herring".

Table 108. Length and number of herring examined. Samsø.

cm.	April	May	June	Total No. Spring	Sept.	Oct.	Nov.	Total No. Autumn
13.....	..	2	..	2	..	..	.	.
14.....	..	5	..	5	.	..	..	..
15.....	..	5	..	5	..	..	..	.
16.....	..	..	..		..	..	..	
17.....	..	..	..	..	..	4	3	7
18.....	..	..	..	..	..	11	6	17
19.....	..	1	1	2	3	17	12	32
20.....	4	..	..	4	8	14	17	39
21.....	9	17	4	30	13	31	13	57
22.....	17	25	4	46	31	39	15	85
23.....	21	28	6	55	44	38	..	82
24.....	8	25	4	37	22	30	4	56
25.....	8	16	..	24	7	16	..	23
26.....	8	8	1	17	1	2	..	3
27.....	2	7	..	9	1	..	..	1
28.....	..	..	..	..	..	1	..	1

The Samsø waters are frequented by both spring-spawning and autumn-spawning herring, and a considerable proportion of the present material consists of mature fish. The degree of maturity was determined by measuring the maximal breadth of the genital organs (see p. 9). In Table 109 (p. 64), the breadth is given in mm. and the other figures indicate the numbers of herring.

In the spring, a very considerable portion of the material consists of spawning and full herring, immature fish and spents being comparatively few in number. In autumn, we have two fairly well defined groups, viz. fish with genital organs less than 12 mm. broad, and those over 15 mm. The last group comprises spawning and full herring, the fish with genital organs less developed being either immature or spent. According to the present investigations, the spring spawning takes place in April and May, the autumn spawning in September and the first half of October.

Table 109. Maximal breadth of genital organs in herring from different months. Samsø.

(Fish over 17 cm. total length).

Breadth in mm.	April	May	June	Sept.	Oct.	Nov.
2	..	1	..	1	10	8
3	..	1	..	4	7	10
4	..	1	..	5	13	15
5	3	4	..	8	33	13
6	3	2	1	10	28	6
7	2	4	2	13	31	3
8	2	4	1	4	20	..
9	..	1	..	5	10	1
10	..	1	1	2	7	2
11	2	1	1	1	3	1
12	2	3	1	1	1	3
13	4	2	1	..	4	..
14	..	5	..	2	..	..
15	9	12	..	3	1	..
16	1	17	1	8	9	1
17	7	5	2	5	5	1
18	7	15	5	9	4	..
19	8	9	2	10	2	2
20	8	9	1	10	2	..
21	6	8	..	13	3	..
22	3	7	1	7	1	1
23	2	6	..	4	1	..
24	5	5	..	5	2	..
25	1	2	..	..	1	..
26	1	1	..	..	1	..
27	..	1	..	..	..	..

b. The relative numbers of herring containing food in the different samples.

Table 110 below shows the percentages of adult herring with definite stomach contents in the different samples.

It will be noted that the percentage of herring with food was on the whole, higher for the spring than for the autumn. Out of the total material from spring 1924 and 1925, we find 87.1 % and 79.4 % respectively with food (average 83.2 %), whereas the percentages for the autumn 1923, 1924 and 1925 were 47.9, 61.8 and 47.8 respectively (average 52.5 %).

If we consider the feeding at these two seasons in connection with the degree of maturity of the herring, we find that fish at all stages of maturity feed to a considerably greater extent in spring than in autumn. This is illustrated by the figures in Table 111 (p. 65) showing numbers of spring herring and autumn herring with food at the different stages of genital development.

It will be noted that the percentages are considerably lower in autumn than in spring, but that we have, in both seasons, the lowest figures among herring with genital organs less than 5 mm. broad and those over 20 mm. The former group comprises immature and spent herring, the latter consisting of full and spawning fish.

Table 110. Percentages of herring containing food in the different samples. Samsø.

(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined.)

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	20.0 (4 : 20)	65.0 (13 : 20)	60.0 (12 : 20)	100.0 (20 : 20)	55.0 (11 : 20)	30.0 (6 : 20)	5.0 (1 : 20)	x
1924	x	x	100.0 (16 : 16)	70.0 (14 : 20)	100.0 (19 : 19)	94.4 (17 : 18)	75.0 (15 : 20)	x	x	45.5 (10 : 22)	100.0 (20 : 20)	60.0 (12 : 20)	60.0 (12 : 20)	45.0 (9 : 20)	x	x	x
1925	85.0 (17 : 20)	85.7 (18 : 21)	95.0 (19 : 20)	80.0 (20 : 25)	68.0 (17 : 25)	65.0 (13 : 20)	x	x	x	46.2 (12 : 26)	59.1 (13 : 22)	54.5 (12 : 22)	44.0 (11 : 25)	38.9 (14 : 36)	50.0 (15 : 30)	x	x

c. Brief survey of the composition of the food.

Examination of the relative numbers of adult herring containing crustaceous and non-crustaceous food gives the result shown in Table 112.

Crustaceans are far more important as herring food than other items, but at the close of the spring fishery and beginning of the autumn fishery we find as a rule comparatively large numbers of herring with non-crustaceous food. On considering the total material of herring from the spring and autumn fishery, we find crustacea in 96.8 % spring and 87.9 % autumn, the corresponding figures for herring

with non-crustaceans being 22.2 % and 53.1 %. These figures suggest that non-crustaceous food is decidedly more important in the autumn.

We will then proceed to consider the percentage of adult fish containing the various groups of organisms. The figures are given in Table 113 (p. 67) and the results shown graphically in Fig. 5, p. 66. Isopoda, cumacea, lamellibranchiata and bryozoa are of altogether subordinate importance, and have therefore not been included in the graph. In Fig. 5, the spring and the autumn material are taken separately, so that the importance of the various organisms as food for the herring at the two seasons can be directly compared. In the spring, copepods, cladocerans and fish eggs predominate. The same items are also of great importance as herring food in the autumn, but at this season, a number of other organisms appear as important elements in the food. Mysids, amphipods, decapods and gastropods for instance, are very infrequently found in the food in spring, whereas in autumn, they are noted in a considerable number of cases. Chætognaths and appendicularians have not been observed in the food in spring, but were found in several of the autumn samples.

Table 111. Percentages of herring with food, spring and autumn, in relation to degree of maturity. Samsø.

(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined.)

Maximal breadth of genital organs	Spring %	Autumn %
2—4 mm.	66.7 (2 : 3)	35.6 (26 : 73)
5—9 —	75.9 (22 : 29)	61.1 (113 : 185)
10—14 —	95.8 (23 : 24)	48.2 (13 : 27)
15—19 —	88.0 (88 : 100)	48.3 (29 : 60)
> 20 —	73.1 (49 : 67)	43.1 (22 : 51)

Table 114 (p. 67) shows the mean monthly percentage of herring containing the different organisms, which gives a clearer view of the position.

Table 112. Percentages of herring containing crustaceous and non-crustaceous food in the different samples. Samsø.

Crustaceous food.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	50.0 (2 : 4)	61.5 (8 : 13)	91.7 (11 : 12)	95.0 (19 : 20)	100.0 (11 : 11)	100.0 (6 : 6)	100.0 (1 : 1)	x
1924.....	x	x	100.0 (16 : 16)	100.0 (14 : 14)	100.0 (19 : 19)	100.0 (17 : 17)	100.0 (15 : 15)	x	x	100.0 (10 : 10)	90.0 (18 : 20)	91.7 (11 : 12)	100.0 (12 : 12)	100.0 (9 : 9)	x	x	x
1925.....	100.0 (17 : 17)	100.0 (18 : 18)	100.0 (19 : 19)	100.0 (20 : 20)	94.1 (16 : 17)	61.5 (8 : 13)	x	x	x	83.3 (10 : 12)	69.2 (9 : 13)	100.0 (12 : 12)	72.7 (8 : 11)	71.4 (10 : 14)	100.0 (15 : 15)	x	x

Non-crustaceous food.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	50.0 (2 : 4)	76.9 (10 : 13)	58.3 (7 : 12)	70.0 (14 : 20)	81.8 (9 : 11)	0	0	x
1924.....	x	x	18.7 (3 : 16)	14.3 (2 : 14)	42.1 (8 : 19)	35.3 (6 : 17)	20.0 (3 : 15)	x	x	30.0 (3 : 10)	90.0 (18 : 20)	50.0 (6 : 12)	33.3 (4 : 12)	0	x	x	x
1925.....	11.8 (2 : 17)	5.6 (1 : 18)	0	15.0 (3 : 20)	17.6 (3 : 17)	76.9 (10 : 13)	x	x	x	33.3 (4 : 12)	69.2 (9 : 13)	50.0 (6 : 12)	36.4 (4 : 11)	57.1 (8 : 14)	40.0 (6 : 15)	x	x

d. Systematic survey of the occurrence of the different organisms in the food.

In the systematic survey given below will be found noted the importance of the different species as herring food. The crustaceans will first be dealt with, and the various other organisms thereafter. Where not otherwise stated, the data refer solely to adult herring (over 17 cm. length). For explanation of tables, see notes on p. 11. A detailed survey of the stomach analyses of two herring samples from Samsø will be found in Tables IX—X, p. 138.

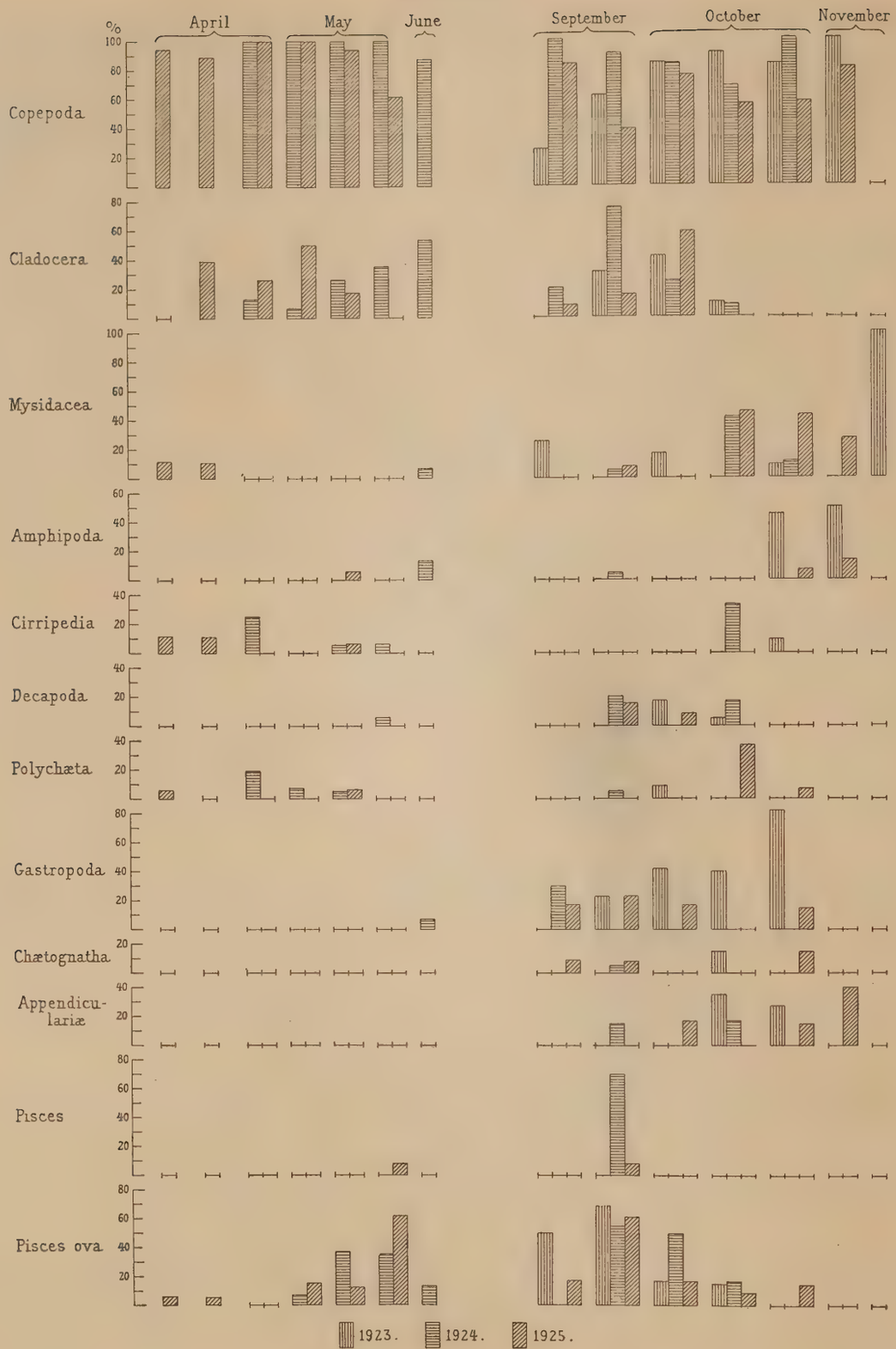


Fig. 5. Percentages of herring stomachs, containing the more important groups of organisms, in the different samples examined. Samsø.

Table 113. Percentages of herring containing the various groups of organisms, calculated from the total number of feeding herring in the respective samples. Samsø.

	Spring fishery											Autumn fishery																
	1924					1925						1923						1924						1925					
	Apr.	May			June	April			May			Sept.	Oct.			Nov.		Sept.	Oct.				Sept.	Oct.			Nov.	
Copepoda	100.0	100.0	100.0	100.0	86.7	94.1	88.9	100.0	100.0	94.1	61.5	25.0	61.5	83.3	90.0	81.8	100.0	—	100.0	90.0	83.3	66.7	100.0	83.3	38.5	75.0	54.5	57.1	80.0
Cladocera	12.5	7.1	26.3	35.3	53.3	—	38.9	26.3	50.0	17.6	—	—	30.8	41.7	10.0	—	—	—	20.0	75.0	25.0	8.3	—	8.3	15.4	58.3	—	—	—
Mysidacea	—	—	—	—	6.7	11.8	11.1	—	—	—	—	25.0	—	16.7	—	9.1	—	100.0	—	5.0	—	41.7	11.1	—	7.7	—	45.5	42.9	26.7
Amphipoda	—	—	—	—	13.3	—	—	—	—	5.9	—	—	—	—	—	45.5	50.0	—	—	5.0	—	—	—	—	—	—	—	7.1	13.3
Isopoda	12.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.1	—	—	—	5.0	—	—	—	—	—	—	—	—	6.7
Cirripedia	25.0	—	5.3	5.9	—	11.8	11.1	—	—	5.9	—	—	—	—	—	9.1	—	—	—	—	—	33.3	—	—	—	—	—	—	—
Decapoda	—	—	—	5.9	—	—	—	—	—	—	—	—	—	16.7	5.0	—	—	—	—	20.0	—	16.7	—	—	15.4	8.3	—	—	—
Cumacea	—	—	—	—	—	5.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Polychæta	18.7	7.1	5.3	—	—	5.9	—	—	—	5.9	—	—	—	8.3	—	—	—	—	—	5.0	—	—	—	—	—	—	36.4	7.1	—
Gastropoda	—	—	—	—	6.7	—	—	—	—	—	—	—	23.1	41.7	40.0	81.8	—	—	30.0	—	—	—	—	16.7	23.1	16.7	—	14.3	—
Lamellibranch.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.0	—	—	—	—	—	—	—	—	—	—	—	—	—	-
Bryozoa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.1	—	—	—	—	—	—	—	—	—	—	—	—	—
Chætognatha	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15.0	—	—	—	—	5.0	—	—	—	8.3	7.7	—	—	14.3	—
Appendiculariæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	35.0	27.3	—	—	—	15.0	—	16.7	—	—	—	16.7	—	14.3	40.0
Pisces	—	—	—	—	—	—	—	—	—	—	7.7	—	—	—	—	—	—	—	—	70.0	—	—	—	—	7.7	—	—	—	—
Pisces ova	—	7.1	36.8	35.3	13.3	5.9	5.6	—	15.0	11.8	61.5	50.0	69.2	16.7	15.0	—	—	—	—	55.0	50.0	16.7	—	16.7	61.5	16.7	9.1	14.3	—

Cladocera.

Both in spring and autumn, the cladocerans play quite a considerable part in the food of the herring from Samsø waters (Table 115, p. 68).

Cladocerans appear in the stomach contents in nearly all the spring samples, whereas in autumn, they are not noted in samples from the end of October and from November. In the spring of 1924 and 1925 herring containing cladocerans amount to 27.2 % and 24.0 % respectively of all those containing food. Reckoning the autumn samples only from mid-September to mid-October, we obtain, for the autumn seasons of 1923, 24 and 25 respectively, 22.4, 38.9 and 20.8 % herring containing cladocerans.

As shown in Table 116 (p. 68), the average number of cladocerans per herring lies between 1 and 5, save for the sample from the end of September 1924, where the average is 15. It is interesting to note that the number of copepods in this sample was also unusually large (see p. 69). Disregarding this one sample, the cladocerans seem on the whole to be taken as food to a greater extent in spring than in autumn. Of the two genera *Evadne* and *Podon*, the latter appears in by far the greater numbers, constituting 92.9 % of all cladocerans.

Evadne sp. Specimens of the genus *Evadne* are only found in the food of a comparatively small number of herring (Table 117, p. 68).

The average number per herring in the individual samples amounts at the utmost to 2, and the greatest number of specimens found in a single stomach is 3. *E. Nordmanni* Lovén appears in the stomach contents in both spring and autumn, whereas *E. spinifera* P. E. Müller is only noted with certainty in the autumn, which agrees well with the occurrence of the two species in the plankton samples (see Table 118, p. 68).

Table 114. Mean monthly percentage of herring containing the different groups of organisms. Samsø.

	April	May	June	Sept.	Oct.	Nov.
Copepoda	97.2	94.0	86.7	68.7	76.7	82.8
Cladocera	17.8	25.0	53.3	30.7	15.8	—
Mysidacea	4.6	—	6.7	4.4	18.3	20.5
Amphipoda	—	1.0	13.3	1.1	4.8	28.1
Isopoda	6.2	—	—	1.1	0.8	3.3
Cirripedia	17.1	3.0	—	—	4.8	—
Decapoda	—	1.0	—	7.1	5.2	—
Cumacea	0.9	—	—	—	—	—
Polychæta	10.3	3.0	—	1.1	5.3	—
Gastropoda	—	—	6.7	15.9	20.6	—
Lamellibranchiata	—	—	—	—	0.8	—
Bryozoa	—	—	—	—	0.8	—
Chætognatha	—	—	—	3.8	4.1	—
Appendiculariæ	—	—	—	3.3	13.3	20.0
Pisces	—	1.0	—	16.9	—	—
Pisces ova	1.8	27.0	13.3	47.1	16.4	—

Table 115. Percentages of herring containing cladocerans in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	30.8 (4 : 13)	41.7 (5 : 12)	10.0 (2 : 20)	—	—	—	x
1924.....	x	x	12.5 (2 : 16)	7.1 (1 : 14)	26.3 (5 : 19)	35.3 (6 : 17)	53.3 (8 : 15)	x	x	20.0 (2 : 10)	75.0 (15 : 20)	25.0 (3 : 12)	8.3 (1 : 12)	—	x	x	x
1925.....	—	38.9 (7 : 18)	26.3 (5 : 19)	50.0 (10 : 20)	17.6 (3 : 17)	—	x	x	x	8.3 (1 : 12)	15.4 (2 : 13)	58.3 (7 : 12)	—	—	—	x	x

Table 116. Average number of cladocerans, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	1 (5 : 4)	1 (5 : 5)	1 (2 : 2)	—	—	—	x
1924.....	x	x	1 (3 : 2)	1 (1 : 1)	3 (16 : 5)	4 (23 : 6)	4 (35 : 8)	x	x	1 (2 : 2)	15 (226 : 15)	1 (4 : 3)	1 (1 : 1)	—	x	x	x
1925.....	—	4 (27 : 7)	5 (24 : 5)	2 (24 : 10)	1 (4 : 3)	—	x	x	x	1 (1 : 1)	1 (3 : 2)	2 (16 : 7)	—	—	—	x	x

Table 117. Percentages of herring containing Evadne in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	15.4 (2 : 13)	16.7 (2 : 12)	5.0 (1 : 20)	—	—	—	x
1924.....	x	x	—	—	—	—	26.7 (4 : 15)	x	x	20.0 (2 : 10)	—	—	—	—	x	x	x
1925.....	—	—	10.5 (2 : 19)	5.0 (1 : 20)	11.8 (2 : 17)	—	x	x	x	8.3 (1 : 12)	15.4 (2 : 13)	25.0 (3 : 12)	—	—	—	x	x

Table 118. Occurrence of Evadne Nordmanni and Evadne spinifera in plankton samples, and of the genus Evadne in herring samples. Samsø.

			April	May	June	Sept.	Oct.	Nov.
Plankton samples	Evadne Nordmanni	1923.....				●	⊗⊗○	○○○
		1924.....	⊗	○⊗●	●	⊗⊗	⊗⊗○	
		1925.....	○⊗●	⊗⊗●		●●	⊗○⊗	○
	Evadne spinifera	1923.....				⊗	⊗○○	○○○
		1924.....	○	○○○	○	●⊗	⊗○○	
		1925.....	○○○	○○○		●●	○○○	○
Herring samples	Evadne sp.	1923.....				○⊕	⊕⊕○	○○
		1924.....	○	○○○	⊕	⊕○	○○○	
		1925.....	○○⊕	⊕⊕○		⊕⊕	⊕○○	○

Podon sp. This genus is, as already mentioned, far more important than the genus *Evadne* as herring food in Samsø waters. Table 119, which gives the percentages of herring containing *Podon,* shows that the percentages are on the whole considerably higher than those for *Evadne* (see Table 117).

Table 119. Percentages of herring containing Podon in the different samples. Samsø.

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	—	23.1 (3 : 13)	25.0 (3 : 12)	5.0 (1 : 20)	—	—	—	x
1924	x	x	12.5 (2 : 16)	7.1 (1 : 14)	26.3 (5 : 19)	35.3 (6 : 17)	46.7 (7 : 15)	x	x	—	75.0 (15 : 20)	25.0 (3 : 12)	8.3 (1 : 12)	—	x	x	x
1925	—	38.9 (7 : 18)	26.3 (5 : 19)	50.0 (10 : 20)	5.9 (1 : 17)	—	x	x	x	—	7.7 (1 : 13)	50.0 (6 : 12)	—	—	—	x	x

In the sample from the end of September 1924, the average number of *Podon* per fish was 15. In the remaining autumn samples, the average was 1—2, and in the spring samples 1—4 specimens. Table X, p. 138 gives a detailed survey of the stomach analyses for the sample from the end of September 1924, showing that *Podon* was found in considerable numbers in some of the fish.

As a rule, it was not possible, in the stomach analyses, to identify the different species of the genus *Podon*; the three following however, were observed in the plankton samples: *Podon Leuckarti* G. O. Sars, *P. intermedius* Lillj., and *P. polyphemoides* (Leuck.). Of these, *P. intermedius* was by far the most frequent. Its occurrence in the plankton samples will be seen from Table 120 together with a statement of the herring samples in which the genus *Podon* appeared in the food.

Table 120. Occurrence of Podon intermedius in plankton samples, and of the genus Podon in herring samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923				⊗	⊗○○	○○○
	1924	⊗	○⊗●	●	●●	●⊗○	
	1925	○⊗⊗	●⊗○		●●	⊗○○	○
Herring samples	1923				○⊕	⊕⊕○	○○
	1924	⊕	⊕⊕⊕	⊕	○⊕	⊕⊕○	
	1925	○⊕⊕	⊕⊕○		○⊕	⊕○○	○

P. Leuckarti was found several times both in summer and autumn in the plankton samples, but always in very small numbers; *P. polyphemoides* was only noted once, to wit, a single specimen in the sample from $^{21}/_{9}$ 25.

Copepoda.

The copepods play a great part in the food of the herring from Samsø, as will be seen from Table 121 showing the percentage of herring containing copepods.

Table 121. Percentages of herring containing copepods in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	25.0 (1 : 4)	61.5 (8 : 13)	83.3 (10 : 12)	90.0 (18 : 20)	81.8 (9 : 11)	100.0 (6 : 6)	—	x
1924.....	x	x	100.0 (16 : 16)	100.0 (14 : 14)	100.0 (19 : 19)	100.0 (17 : 17)	86.7 (13 : 15)	x	x	100.0 (10 : 10)	90.0 (18 : 20)	83.3 (10 : 12)	66.7 (8 : 12)	100.0 (9 : 9)	x	x	x
1925.....	94.1 (16 : 17)	88.9 (16 : 18)	100.0 (19 : 19)	100.0 (20 : 20)	94.1 (16 : 17)	61.5 (8 : 13)	x	x	x	83.3 (10 : 12)	38.5 (5 : 13)	75.0 (9 : 12)	54.5 (6 : 11)	57.1 (8 : 14)	80.0 (12 : 15)	x	x

In the material from the spring of 1924 and 1925, copepods appear in the food of 97.5 and 91.3 % respectively of all herring containing food, whereas the corresponding figures for the autumn of 1923, 24 and 25 are 77.6, 87.3 and 64.9 %. On the whole, copepods appear in the food of the herring in far greater numbers in spring than in autumn, as will be seen from the table below.

Table 122. Average number of copepods, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	2 (2 : 1)	11 (91 : 8)	6 (59 : 10)	16 (294 : 18)	6 (58 : 9)	2 (13 : 6)	—	x
1924.....	x	x	1043 (16.788 : 16)	374 (5233 : 14)	1438 (27324 : 19)	162 (2756 : 17)	11 (146 : 13)	x	x	2 (25 : 10)	369 (6649 : 18)	4 (41 : 10)	12 (94 : 8)	1 (13 : 9)	x	x	x
1925.....	22 (359 : 16)	78 (1246 : 16)	38 (726 : 19)	47 (933 : 20)	9 (150 : 16)	2 (20 : 8)	x	x	x	3 (27 : 10)	2 (9 : 5)	2 (17 : 9)	3 (18 : 6)	2 (17 : 8)	2 (27 : 12)	x	x

In the spring of 1924, the averages were very considerably higher than those for the spring of 1925, and the sample from the end of September 1924 also showed an unusually high average compared with the other autumn samples.

Many of the herring examined from this last-named sample were found to contain considerable numbers of copepods, as will be seen from the detailed survey p. 138, Table X.

Analysis of the stomach contents of herring from Samsø showed the following copepods:

Calanus finmarchicus (Gunner.)
Pseudocalanus elongatus Boeck
Paracalanus parvus Claus
Centropages typicus Krøyer
Centropages hamatus (Lillj.)
Isias clavipes Boeck
Temora longicornis (O. F. Müller)
Acartia longiremis (Lillj.)
Acartia Clausi Giesbrecht
Oithona similis Claus
Ectinosoma sp.
Microsetella norvegica (Boeck)
Harpacticus sp.
Caligus sp.

In the following, the species *Pseudocalanus elongatus* and *Paracalanus parvus* are taken together. The same applies to the species of the genus *Acartia* and the harpacticids respectively.

Taking the spring and autumn material separate, we obtain the following figures showing the relative importance of the various copepods as herring food during the different years:

Table 123. Relative importance of the various copepods as food for the herring in the spring of 1924 and 25, and autumn 1923, 24 and 25. Samsø.

	Spring				Autumn					
	1924		1925		1923		1924		1925	
	No.	%	No.	%	No.	%	No.	%	No.	%
Calanus finmarchicus	738	1.49	7	0.24	3	1.18	19	0.28	10	9.90
Pseudocal. + Paracalanus	39335	79.28	2094	73.09	183	68.80	6407	95.06	53	52.48
Centropages typicus	—	—	—	—	—	—	—	—	1	0.99
Centropages hamatus	1392	2.80	325	11.34	23	8.65	62	0.92	8	7.92
Isias clavipes	—	—	—	—	1	0.37	1	0.02	4	3.96
Temora longicornis	8058	16.24	367	12.81	30	11.28	241	3.58	11	10.89
Acartia sp.	68	0.14	25	0.87	25	9.40	9	0.13	12	11.88
Oithona similis	1	0.01	3	0.11	—	—	1	0.01	1	0.99
Harpacticidæ	20	0.04	43	1.50	1	0.37	—	—	1	0.99
Caligus sp.	—	—	1	0.04	—	—	—	—	—	—

Comparison of the relative quantities for the spring of 1924 and 1925 shows in the main a good agreement between the two, *Pseudocalanus* + *Paracalanus* being by far the most important copepods; then come *Temora* and *Centropages*

Table 124. Percentages of herring containing the different copepods. Samsø.

	Spring fishery											Autumn fishery																				
	1924					1925						1923						1924						1925								
	Apr.	May			June	April			May			Sept.	October			Nov.		Sept.	October				Sept.	October			Nov.				
Calanus finmarchicus	25.0	78.6	31.6	94.1	6.7	5.9	—	21.1	5.0	—	7.7	—	—	8.3	5.0	9.1	—	—	—	40.0	—	—	—	—	—	25.0	9.1	21.4	6.7			
Pseudocalanus + Paracalanus	100.0	100.0	100.0	88.2	80.0	76.5	83.3	94.7	95.0	47.1	23.1	—	61.5	66.7	55.0	18.2	—	—	70.0	85.0	75.0	66.7	77.8	75.0	30.8	50.0	27.3	28.6	53.3			
Centropages typ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.3	—	—	—	—	—			
Centropages ham.	81.2	85.7	47.4	52.9	53.3	35.3	55.6	31.6	60.0	29.4	23.1	—	7.7	8.3	—	45.5	—	—	10.0	25.0	25.0	41.7	—	8.3	7.7	8.3	9.1	—	13.3			
Isias clavipes	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.1	—	—	—	—	8.3	—	—	—	—	—	—	14.3	—			
Temora longicorn.	81.2	85.7	100.0	82.4	73.3	58.8	61.1	31.6	40.0	76.5	15.4	—	7.7	25.0	30.0	9.1	16.7	—	10.0	70.0	16.7	25.0	22.2	8.3	—	8.3	9.1	7.1	20.0			
Acartia sp.	31.2	—	10.5	17.6	26.7	5.9	5.6	—	20.0	29.4	15.4	—	—	16.7	25.0	36.4	50.0	—	30.0	5.0	16.7	8.3	22.2	8.3	—	8.3	—	7.1	33.3			
Oithona similis	6.2	—	—	—	—	5.9	—	—	—	11.8	—	—	—	—	—	—	—	—	—	5.0	—	—	—	—	7.7	—	—	—	—			
Harpacticidæ	6.2	35.7	—	—	6.7	23.5	16.7	5.3	40.0	23.5	23.1	—	—	—	—	—	16.7	—	—	—	—	—	—	—	7.7	—	—	—	—			
Caligus sp.	—	—	—	—	—	—	—	5.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			

hamatus, the remaining copepods being of but very slight importance. In autumn, the sequence is very much the same, and the three years are very much alike, though the 1923 and 1924 material is but scanty.

The above calculations include of course only those copepods which could be referred to one of the categories noted. Unidentifiable copepods amount to only ca. 6 % of all copepods, and could thus hardly affect the results here given to any essential degree. To illustrate further the importance of the different copepods as food, we will consider the relative numbers of herring in which these are found, calculated from the total number of feeding herring in the respective samples (Table 124, p. 70).

Generally speaking, most copepods appear in the stomach contents to a far greater extent in spring than in autumn, as is plainly apparent when we consider the number of the most important copepods found on the average per fish, for the two seasons (Table 125).

Table 125. Average number of principal copepods per herring containing the respective species. Samsø.

	1924					1925						1923						1924					1925					
	April	May			June	April			May			Sept.		Oct.			Nov.		Sept.		Oct.			Sept.		Oct.			Nov.
Calanus finmarchicus	2	28	4	24	10	1	—	1	1	—	1	—	—	1	1	1	—	—	—	2	—	—	—	—	—	1	1	1	1
Pseudocal. + Paracalanus .	882	282	1042	97	2	10	42	31	39	2	1	—	2	3	12	3	—	—	2	372	3	4	1	2	1	2	1	1	1
Centropages hamatus.....	64	28	15	4	5	10	19	2	3	2	1	—	7	2	—	3	—	—	1	3	2	9	—	2	1	1	1	—	1
Temora longicornis	82	27	325	32	4	5	17	5	1	6	2	—	14	3	1	1	3	—	1	16	2	4	1	2	—	1	1	3	1

On the whole, the herring feed on these different species to a far greater extent in spring than in autumn; the sample from the end of September 1924 however, already referred to, is, as regards *Pseudocalanus* + *Paracalanus*, a marked exception among the autumn samples generally.

Calanus finmarchicus. Taking the total number of copepods found in the stomach analyses of herring from Samsø, *Calanus* makes but a very small percentage (1.3 %); during one season, however, the spring fishery of 1924, it appeared in relatively great numbers of the herring examined (Table 126).

Table 126. Percentages of herring containing Calanus finmarchicus in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	8.3 (1 : 12)	5.0 (1 : 20)	9.1 (1 : 11)	—	—	x
1924.....	x	x	25.0 (4 : 16)	78.6 (11 : 14)	31.6 (6 : 19)	94.1 (16 : 17)	6.7 (1 : 15)	x	x	—	40.0 (8 : 20)	—	—	—	x	x	x
1925.....	5.9 (1 : 17)	—	21.1 (4 : 19)	5.0 (1 : 20)	—	7.7 (1 : 13)	x	x	x	—	—	25.0 (3 : 12)	9.1 (1 : 11)	21.4 (3 : 14)	6.7 (1 : 15)	x	x

Calculating the percentage for the entire material from the spring of 1924 and 1925, we obtain 46.9 and 6.7 % respectively. For purposes of comparison it may be noted that the relative numbers of herring containing *Calanus* in the autumn of 1923, 1924 and 1925 respectively were 4.5, 12.7 and 10.4 %.

The average number of *Calanus* per herring (Table 127) in the spring of 1924 was also unusually great.

Table 127. Average number of Calanus finmarchicus, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	1 (1 : 1)	1 (1 : 1)	1 (1 : 1)	—	—	x
1924.....	x	x	2 (9 : 4)	28 (303 : 11)	4 (25 : 6)	24 (391 : 16)	10 (10 : 1)	x	x	—	2 (19 : 8)	—	—	—	x	x	x
1925.....	1 (1 : 1)	—	1 (4 : 4)	1 (1 : 1)	—	1 (1 : 1)	x	x	x	—	—	1 (4 : 3)	1 (1 : 1)	1 (4 : 3)	1 (1 : 1)	x	x

The species appeared fairly frequently in the plankton samples, but only a few specimens at a time; even in the samples from the spring of 1924, when *Calanus* was particularly numerous in the food of the herring, only relatively small numbers appeared in the plankton samples (Table 128).

Table 128. Calanus finmarchicus. Occurrence in plankton samples and in herring samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923				○	⊗○⊗	○○○
	1924	⊗	⊗○⊗	○	○⊗	○○○	
	1925	○○⊗	○⊗○		○○	○○⊗	○
Herring samples	1923				○○	⊕⊕⊕	○○
	1924	⊕	⊕⊕⊕	⊕	○⊕	○○○	
	1925	⊕○⊕	⊕○⊕		○○	⊕⊕⊕	⊕

Pseudocalanus elongatus and *Paracalanus parvus*. These species are by far the most important copepods in the food of the herring from Samsø (80.7 % of all copepods). Both in spring and in autumn they are found in the stomachs of a large number of herring.

Table 129. Percentages of herring containing Pseudocalanus + Paracalanus in the different samples. Samsø.

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	—	61.5 (8 : 13)	66.7 (8 : 12)	55.0 (11 : 20)	18.2 (2 : 11)	—	—	x
1924	x	x	100.0 (16 : 16)	100.0 (14 : 14)	100.0 (19 : 19)	88.2 (15 : 17)	80.0 (12 : 15)	x	x	70.0 (7 : 10)	85.0 (17 : 20)	75.0 (9 : 12)	66.7 (8 : 12)	77.8 (7 : 9)	x	x	x
1925	76.5 (13 : 17)	83.3 (15 : 18)	94.7 (18 : 19)	95.0 (19 : 20)	47.1 (8 : 17)	23.1 (3 : 13)	x	x	x	75.0 (9 : 12)	30.8 (4 : 13)	50.0 (6 : 12)	27.3 (3 : 11)	28.6 (4 : 14)	53.3 (8 : 15)	x	x

The percentages for the total material from the spring of 1924 and 1925 are 93.8 and 73.1 respectively, the figures for autumn 1923, 1924 and 1925 being 43.3, 76.2 and 44.2 % respectively.

Calculations of the average number per fish show that the importance of the two species as herring food is on the whole far greater in spring than in autumn (Table 130). The sample from the end of September 1924, however, shows a remarkably high average.

Table 130. Average number of Pseudocalanus + Paracalanus, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	—	2 (20 : 8)	3 (26 : 8)	12 (130 : 11)	3 (7 : 2)	—	—	x
1924	x	x	882 (14115 : 16)	282 (3947 : 14)	1042 (19797 : 19)	97 (1451 : 15)	2 (25 : 12)	x	x	2 (13 : 7)	372 (6323 : 17)	3 (28 : 9)	4 (34 : 8)	1 (9 : 7)	x	x	x
1925	10 (135 : 13)	42 (635 : 15)	31 (565 : 18)	39 (741 : 19)	2 (15 : 8)	1 (3 : 3)	x	x	x	2 (18 : 9)	1 (6 : 4)	2 (10 : 6)	1 (4 : 3)	1 (5 : 4)	1 (10 : 8)	x	x

Table 131 shows that *Pseudocalanus* is particularly abundant in the plankton in spring, *Paracalanus* having its maximum in the autumn. The great quantity of these copepods found in the food in spring is thus doubtless made up chiefly of the former species.

Table 131. Pseudocalanus elongatus and Paracalanus parvus. Occurrence in plankton samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Pseudocalanus elongatus	1923				●	⊗⊗⊗	⊗●⊗
	1924	●	●●●	●	⊗⊗	●●⊗	
	1925	●●●	●⊗⊗		⊗⊗	⊗●⊗	⊗
Paracalanus parvus	1923				●	●●●	●●●
	1924	⊗	⊗⊗⊗	⊗	●●	●●●	
	1925	⊗⊗⊗	⊗⊗⊗		●●	●●●	⊗

Centropages typicus. Only a single specimen of this species was found in the food (10/9 25). In the plankton samples also it was only noted on the 10/9 25.

Centropages hamatus. This species amounted to only 3 % of all copepods, but was nevertheless frequently found in the food, especially in spring.

Table 132. Percentages of herring containing Centropages hamatus in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	7.7 (1 : 13)	8.3 (1 : 12)	—	45.5 (5 : 11)	—	—	x
1924.....	x	x	81.2 (13 : 16)	85.7 (12 : 14)	47.4 (9 : 19)	52.9 (9 : 17)	53.3 (8 : 15)	x	x	10.0 (1 : 10)	25.0 (5 : 20)	25.0 (3 : 12)	41.7 (5 : 12)	—	x	x	x
1925.....	35.3 (6 : 17)	55.6 (10 : 18)	31.6 (6 : 19)	60.0 (12 : 20)	29.4 (5 : 17)	23.1 (3 : 13)	x	x	x	8.3 (1 : 12)	7.7 (1 : 13)	8.3 (1 : 12)	9.1 (1 : 11)	—	13.3 (2 : 15)	x	x

Calculating the percentages for the total number from the spring of 1924 and 1925, we obtain 63.0 and 40.4 respectively, the corresponding figures for autumn 1923, 24 and 25 being 10.4, 22.2 and 7.8 %.

The average number of *Centropages hamatus* per fish likewise shows considerably higher values for spring than for autumn.

Table 133. Average number of Centropages hamatus, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	7 (7 : 1)	2 (2 : 1)	—	3 (14 : 5)	—	—	x
1924.....	x	x	64 (835 : 13)	28 (341 : 12)	15 (135 : 9)	4 (40 : 9)	5 (41 : 8)	x	x	1 (1 : 1)	3 (13 : 5)	2 (5 : 3)	9 (43 : 5)	—	x	x	x
1925.....	10 (63 : 6)	19 (194 : 10)	2 (15 : 6)	3 (39 : 12)	2 (11 : 5)	1 (3 : 3)	x	x	x	2 (2 : 1)	1 (1 : 1)	1 (1 : 1)	1 (1 : 1)	—	1 (3 : 2)	x	x

In the plankton samples from Samsø, this species was particularly common in the spring (Table 134) and it is thus only natural that it should then be more abundant in the herring food.

Table 134. Centropages hamatus. Occurrence in plankton samples and in herring samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923...				⊗	⊗○○	⊗⊗⊗
	1924...	●	●●⊗	●	⊗⊗	⊗●○	
	1925...	●●⊗	●⊗●		⊗●	○○⊗	○
Herring samples	1923...				○⊕	⊕○⊕	○○
	1924...	⊕	⊕⊕⊕	⊕	⊕⊕	⊕⊕○	
	1925...	⊕⊕⊕	⊕⊕⊕		⊕⊕	⊕⊕○	⊕

Isias clavipes. This species is found occasionally in September and October in the food, but never more than a few specimens at a time (6 in all). In the plankton samples also it appeared on a few occasions in autumn, but always in small numbers.

Temora longicornis. Next to the two species *Pseudocalanus + Paracalanus, Temora* is the most important copepod in the food of the herring from Samsø waters (14.6 % of all copepods). The percentage of herring containing the species in the different samples is shown in Table 135.

The percentages are on the whole considerably higher in spring than in autumn. The material from the spring of 1924 and 1925 shows 85.2 and 48.1 % containing *Temora*, the corresponding figures for autumn 1923, 24 and 25 being 17.9, 34.9 and 9.1 %. In the spring of 1924 then, the species appears in the food of a far greater number of herring than in the spring of 1925. This difference in the importance of the species as food in the two years is even more distinctly apparent when we consider the average numbers of *Temora* per fish (Table 136).

Table 135. Percentages of herring containing Temora longicornis in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	7.7 (1 : 13)	25.0 (3 : 12)	30.0 (6 : 20)	9.1 (1 : 11)	16.7 (1 : 6)	—	x
1924.....	x	x	81.2 (13 : 16)	85.7 (12 : 14)	100.0 (19 : 19)	82.4 (14 : 17)	73.3 (11 : 15)	x	x	10.0 (1 : 10)	70.0 (14 : 20)	16.7 (2 : 12)	25.0 (3 : 12)	22.2 (2 : 9)	x	x	x
1925.....	58.8 (10 : 17)	61.1 (11 : 18)	31.6 (6 : 19)	40.0 (8 : 20)	76.5 (13 : 17)	15.4 (2 : 13)	x	x	x	8.3 (1 : 12)	—	8.3 (1 : 12)	9.1 (1 : 11)	7.1 (1 : 14)	20.0 (3 : 15)	x	x

Table 136. Average number of Temora longicornis, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	14 (14 : 1)	3 (8 : 3)	1 (9 : 6)	1 (1 : 1)	3 (3 : 1)	—	x
1924.....	x	x	82 (1060 : 13)	27 (329 : 12)	325 (6176 : 19)	32 (454 : 14)	4 (39 : 11)	x	x	1 (1 : 1)	16 (222 : 14)	2 (5 : 2)	4 (11 : 3)	1 (2 : 2)	x	x	x
1925.....	5 (47 : 10)	17 (191 : 11)	5 (33 : 6)	1 (10 : 8)	6 (82 : 13)	2 (4 : 2)	x	x	x	2 (2 : 1)	—	1 (1 : 1)	1 (1 : 1)	3 (3 : 1)	1 (4 : 3)	x	x

As will be seen from Table 137 *Temora* was particularly abundant in the plankton samples in spring.

Table 137. Temora longicornis. Occurrence in plankton samples and in herring samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923...				⊗	⊗⊗⊗	⊗●●
	1924...	⊗	●●●	●	⊗⊗	⊗●⊗	
	1925...	●●⊗	⊗●⊗		○⊗	○⊗⊗	⊗
Herring samples	1923...				○⊕	⊕⊕⊕	⊕○
	1924...	⊕	⊕⊕⊕	⊕	⊕⊕	⊕⊕⊕	
	1925...	⊕⊕⊕	⊕⊕⊕		⊕○	⊕⊕⊕	⊕

Acartia sp. These copepods, which were often common in the plankton samples, were only found in small numbers in the stomach analyses, a fact which must presumably be attributed to their relatively small size. They were rarely found in the food of any great number of the herring examined.

Table 138. Percentages of herring containing Acartia in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	16.7 (2 : 12)	25.0 (5 : 20)	36.4 (4 : 11)	50.0 (3 : 6)	—	x
1924.....	x	x	31.2 (5 : 16)	—	10.5 (2 : 19)	17.6 (3 : 17)	26.7 (4 : 15)	x	x	30.0 (3 : 10)	5.0 (1 : 20)	16.7 (2 : 12)	8.3 (1 : 12)	22.2 (2 : 9)	x	x	x
1925.....	5.9 (1 : 17)	5.6 (1 : 18)	—	20.0 (4 : 20)	29.4 (5 : 17)	15.4 (2 : 13)	x	x	x	8.3 (1 : 12)	—	8.3 (1 : 12)	—	7.1 (1 : 14)	33.3 (5 : 15)	x	x

There is no essential difference between the percentages for spring and autumn. The relative numbers of herring containing *Acartia*, for all material from the spring of 1924 and 1925 amount to 17.3 and 12.5 %, for autumn 1923, 24 and 25 to 20.9, 14.3 and 10.4 % respectively.

The average number of *Acartia* per herring in the different samples is very small. In spring, the figures vary from 1 to 8, in autumn from 1 to 3. *A. longiremis* is by far the commonest species in the plankton. Less numerous, but noted in several of the samples, is the species *A. Clausi* (Table 139).

In addition to the two species above mentioned, two others, *A. bifilosa* (Giesbr.) and *A. discaudata* (Giesbr.) were recorded, though extremely rare. Single specimens of the former were found in a few samples, *A. discaudata* being observed only in one sample (‰ 24).

Table 139. Acartia longiremis and Acartia Clausi. Occurrence in plankton samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Acartia longiremis	1923				●	⊗⊗⊗	⊗⊗⊗
	1924	●	⊗●⊗	●	⊗⊗	●●⊗	
	1925	⊗⊗⊗	⊗●●		○⊗	⊗⊗●	⊗
Acartia Clausi	1923				⊗	○○○	⊗○○
	1924	⊗	○⊗○	⊗	⊗⊗	⊗○⊗	
	1925	⊗○○	⊗○○		○⊗	○⊗⊗	⊗

Oithona similis. It was only exceptionally that this species appeared as an item in the food, and only isolated specimens were so found (6 in all). It has been noted at various seasons as common in the plankton samples.

Harpacticidæ. Harpacticids were fairly common in the food, especially in spring.

Table 140. Percentages of herring containing harpacticids in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	—	—	—	16.7 (1:6)	—	x
1924.....	x	x	6.2 (1:16)	35.7 (5:14)	—	—	6.7 (1:15)	x	x	—	—	—	—	—	x	x	x
1925.....	23.5 (4:17)	16.7 (3:18)	5.3 (1:19)	40.0 (8:20)	23.5 (4:17)	23.1 (3:13)	x	x	x	—	7.7 (1:13)	—	—	—	—	x	x

Out of the total number of feeding herring from the spring of 1924 and 1925, harpacticids appear in the food of 8.6 and 22.1 %. The corresponding figures for autumn 1923, 24 and 25 are 1.5, 0 and 1.3 %. The average number of harpacticids per herring in the different samples is only small. The samples from the spring for instance show 1—4 per fish, and the autumn samples 1.

The specimens found in the stomach analyses being chiefly young ones, it was only exceptionally that the species could be determined. *Microsetella norvegica* was occasionally identified, and also specimens of the genera *Ectinosoma* and *Harpacticus.* In the plankton samples, *Microsetella norvegica* was noted occasionally both in spring and autumn.

Caligus sp. A herring from the $^{26}/_{4}$ 25 was found to contain a specimen of this genus.

Cirripedia.

Nauplii have only been found once in the food of the herring, cypris stages however, in several cases. Table 141 shows the percentages of herring containing cirripede larvæ.

Table 141. Percentages of herring containing cirripede larvæ in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	—	—	9.1 (1:11)	—	—	x
1924.....	x	x	25.0 (4:16)	—	5.3 (1:19)	5.9 (1:17)	—	x	x	—	—	—	33.3 (4:12)	—	x	x	x
1925.....	11.8 (2:17)	11.1 (2:18)	—	—	5.9 (1:17)	—	x	x	x	—	—	—	—	—	—	x	x

A single nauplius was found on the $^{29}/_{10}$ 23; cypris stages were found in 16 herrings, the number per fish varying from 1 to 7. It will be seen from Table 142 that nauplii only appeared in the plankton samples in autumn, whereas cypris stages were found both in autumn and spring.

Table 142. Occurrence of cirripede larvæ in plankton samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Nauplii	1923				○	○⊗⊗	⊗⊗○
	1924	○	○○○	○	○○	○⊗○	
	1925	○○○	○○○		○⊗	○○⊗	○
Cypris stages	1923				○	○○⊗	○○○
	1924	⊗	○⊗○	○	○○	○⊗○	
	1925	○⊗○	⊗⊗○		○○	○○⊗	○

Mysidacea.

In Samsø waters, the mysids are, especially in autumn, of considerable importance as herring food, as will be seen from the table below.

Table 143. Percentages of herring containing mysids in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	25.0 (1:4)	—	16.7 (2:12)	—	9.1 (1:11)	—	100.0 (1:1)	x
1924.....	x	x	—	—	—	—	6.7 (1:15)	x	x	—	5.0 (1:20)	—	41.7 (5:12)	11.1 (1:9)	x	x	x
1925.....	11.8 (2:17)	11.1 (2:18)	—	—	—	—	x	x	x	—	7.7 (1:13)	—	45.5 (5:11)	42.9 (6:14)	26.7 (4:15)	x	x

The relative number of herring containing mysids amounts to 1.2 and 3.8 % respectively of the total for spring 1924 and 1925, the values for autumn 1923, 24 and 25 being 7.5, 11.1, and 20.8 %.

Table 144 shows the average numbers of mysids per fish.

Table 144. Average number of mysids, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	1 (1:1)	—	1 (2:2)	—	252 (252:1)	—	1 (1:1)	x
1924.....	x	x	—	—	—	—	1 (1:1)	x	x	—	1 (1:1)	—	1 (7:5)	1 (1:1)	x	x	x
1925.....	30 (61:2)	1 (2:2)	—	—	—	—	x	x	x	—	1 (1:1)	—	12 (60:5)	1 (9:6)	4 (16:4)	x	x

The sample from early April 1925 shows a remarkably high average, due to the fact that a single fish contained 60 specimens, whereas otherwise the number of mysids in spring was but small. The averages for the autumn show that large numbers of mysids were found in some of the fish. The sample from $^{29}/_{10}$ 23 for instance, shows one herring with no fewer than 252 mysids in the stomach.

Mysids which could be identified as to species amounted in all to 338, the numbers and percentages being as follows:

Schistomysis spiritus Norm.	252 spec.	74.5 %
Macropsis Slabberi (v. Bened.)	57 —	16.9 —
Gastrosaccus spinifer (Goës)	27 —	8.0 —
Macromysis inermis (Rathke)	1 —	0.3 —
Macromysis flexuosa (O. F. Müller)	1 —	0.3 —

Gastrosaccus spinifer was found in 66.7 % of all herring containing identifiable mysids, but never in any great number per fish (maximum 10). Save for a single exception, it was only noted in the autumn.

Macropsis Slabberi. This species was found in 16.7 % of all herring containing mysids. Save for one fish with 55 specimens in the stomach ($^{14}/_{10}$ 25), only single specimens were found.

Macromysis inermis. A single specimen was found $^{6}/_{11}$ 25.

Macromysis flexuosa. Of this species also a single specimen was noted ($^{24}/_{10}$ 25).

Schistomysis spiritus. The stomach of a herring from $^{29}/_{10}$ 23 was found to contain 252 mysids, all belonging to this species.

Decapoda.

Decapod larvæ were found in the herring food far more frequently in autumn, being noted from the end of September to mid-October (Table 145). Only a very few specimens were found in the individual stomach analyses.

Table 145. Percentages of herring containing decapod larvæ in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	16.7 (2:12)	5.0 (1:20)	—	—	—	x
1924.....	x	x	—	—	—	5.9 (1:17)	—	x	x	—	20.0 (4:20)	—	16.7 (2:12)	—	x	x	x
1925.....	—	—	—	—	—	—	x	x	x	—	15.4 (2:13)	8.3 (1:12)	—	—	—	x	x

Macrura. Larval stages of *Crangon vulgaris* Fabr. were only found in the stomach contents in autumn, and only in small numbers (1—2 specimens per fish).

Brachyura. Save for a single instance in spring ($^{30}/_{5}$ 24), crab larvæ only appeared in the food in autumn. The stomach analyses showed 5 specimens in all, of *Carcinus mœnas* (L).

Cumacea.

A single specimen of the species *Lamprops fasciata* G. O. Sars was found in the stomach contents ($^{7}/_{4}$ 25).

Isopoda.

The genus *Idothea* has been found in the food of the herring from Samsø. Only 6 specimens were noted in the stomach analyses, among which *Idothea baltica* (Pallas) was identified with certainty.

Amphipoda.

The amphipods are of very slight importance as food for the herring in these waters. The stomach analyses showed only 21 specimens, the majority of which were from the autumn.

Table 146. Percentages of herring containing amphipods in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	—	—	45.5 (5:11)	50.0 (3:6)	—	x
1924.....	x	x	—	—	—	—	13.3 (2:15)	x	x	—	5.0 (1:20)	—	—	—	x	x	x
1925.....	—	—	—	—	5.9 (1:17)	—	x	x	x	—	—	—	—	7.1 (1:14)	13.3 (2:15)	x	x

The following species were identified:

Pontoporeia femorata Krøyer. Two specimens found in a herring from $^{8}/_{11}$ 23.

Calliopius Rathkei (Zaddach). A single specimen noted ($^{20}/_{10}$ 23).

Nototropis sp. Three specimens of this genus were found in 2 herring from $^{29}/_{10}$ 23 and $^{6}/_{11}$ 25.

Gammarus locusta L. was the commonest amphipod, and has been found both in spring and autumn, but only in small numbers (12 specimens in all).

Polychæta.

Only a comparatively small number of the herring examined were found to contain polychætes.

From Table 147 it will be seen that polychætes appeared in the food both in spring and autumn. The number of specimens per fish was never great (maximum 8). Polychætes were very often so decomposed that identification was impossible; the following species and genera however, have been recognised with certainty:

Goniada maculata A. S. Ørsted. Eight specimens of this species were found in the stomach of a herring from $^{14}/_{10}$ 25.

Nereis sp. The majority of the polychætes found belong undoubtedly to this genus. The only species identified with certainty was *Nereis pelagica* L.

Tomopteris helgolandica Greeff was found on one occasion ($^{14}/_{10}$ 25) in the food.

Table 147. Percentages of herring containing polychætes in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	—	8.3 (1 : 12)	—	—	—	—	x
1924.....	x	x	18.7 (3 : 16)	7.1 (1 : 14)	5.3 (1 : 19)	—	—	x	x	—	5.0 (1 : 20)	—	—	—	x	x	x
1925.....	5.9 (1 : 17)	—	—	—	5.9 (1 : 17)	—	x	x	x	—	—	—	36.4 (4 : 11)	7.1 (1 : 14)	—	x	x

Gastropoda.

Larval gastropods were not infrequently met with in the food, but, as will be seen from Table 148, their occurrence was practically restricted to the autumn months.

Table 148. Percentages of herring containing larval gastropods in the different samples. Samsø.

	April			May			June		September			October			November		
1923.....	x	x	x	x	x	x	x	x	x	—	23.1 (3 : 13)	41.7 (5 : 12)	40.0 (8 : 20)	81.8 (9 : 11)	—	—	x
1924.....	x	x	—	—	—	—	6.7 (1 : 15)	x	x	30.0 (3 : 10)	—	—	—	—	x	x	x
1925.....	—	—	—	—	—	—	x	x	x	16.7 (2 : 12)	23.1 (3 : 13)	16.7 (2 : 12)	—	14.3 (2 : 14)	—	x	x

In the autumn of 1923, larval gastropods were found in a comparatively large number of herring, viz. 37.3 % of all those containing food. In the autumn of 1924 and 1925, the figures were 4.8 and 11.7 %. The greatest number of gastropod larvæ found in a single fish was 18, and the average per fish in the different samples varied from 1 to 8. Larval gastropods were common in the plankton samples, especially in autumn (Table 149).

Table 149. Occurrence of larval gastropods in plankton samples and in herring samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923				⊗	● ● ●	● ⊗ ○
	1924	○	○ ○ ○	⊗	● ⊗	⊗ ● ○	
	1925	○ ○ ○	⊗ ⊗ ⊗		⊗ ●	● ● ●	●
Herring samples	1923				○ ⊕	⊕ ⊕ ⊕	○ ○
	1924	○	○ ○ ○	⊕	⊕ ○	○ ○ ○	
	1925	○ ○ ○	○ ○ ○		⊕ ⊕	⊕ ○ ⊕	○

Lamellibranchiata.

Lamellibranch larvæ were represented in the food only by a single specimen ($^{16}/_{10}$ 23). It is somewhat remarkable that they should occur so rarely in the food, as they were not infrequent, especially in autumn, in the plankton samples (Table 150).

Table 150. Lamellibranchiata. Occurrence of larval stages in plankton samples. Samsø.

	April	May	June	Sept.	Oct.	Nov.
1923				○	⊗ ● ⊗	● ○ ⊗
1924	○	○ ○ ○	○	⊗ ⊗	○ ● ○	
1925	○ ○ ○	⊗ ○ ●		⊗ ⊗	● ⊗ ○	●

Bryozoa.

Larvæ of bryozoa (*Cyphonautes*) were found only once, three specimens being noted in the stomach of a herring ($^{29}/_{10}$ 23). *Cyphonautes* was extremely common in the autumn plankton samples (Table 151) so that it would seem as if they are only exceptionally taken as food by the herring.

Table 151. Cyphonautes. Occurrence in plankton samples. Samsø.

	April	May	June	Sept.	Oct.	Nov.
1923				⊗	●●●	●●⊗
1924	○	○○○	○	⊗●	●●●	
1925	○○○	○○○		⊗⊗	●●●	⊗

Chætognatha.

Small quantities of *Sagitta* have been found in the food of the Samsø herring in autumn. In 5 autumn samples, the species was noted in 5—15 % of the fish examined. The greatest number observed in a single fish was 2. The plankton samples on the other hand, showed *Sagitta* as very numerous in the autumn (Table 152), which is worth noting in view of the infrequency of this species in the food of the herring.

Table 152. Sagitta. Occurrence in herring samples and in plankton samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923				⊗	●●⊗	●●⊗
	1924	○	⊗○⊗	○	●●	●●⊗	
	1925	○⊗○	⊗⊗○		●⊗	●●●	●
Herring samples	1923				○○	○⊕○	○○
	1924	○	○○○	○	○⊕	○○○	
	1925	○○○	○○○		⊕⊕	○○⊕	○

Appendiculariæ.

The genus *Oikopleura* has repeatedly been noted in the food, and as far as it was possible to refer individuals to their particular species, they were found to belong to *Oikopleura dioica* Fol. This species was found in the food only in autumn; in 7 herring samples from that season it was found in the stomachs of 14.3—40.0 % of the fish examined. The relative numbers of herring containing *Oikopleura*, calculated from the total number of herring containing food, were, for the autumn of 1923 14.9 %, for 1924 7.9 %, and for 1925 13.0 %. As a rule, only small numbers were found in a single fish (maximum 35), and the average number per fish was therefore rather low (Table 153).

Table 153. Average number of Oikopleura, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	—	—	—	8 (53 : 7)	3 (8 : 3)	—	—	x
1924	x	x	—	—	—	—	—	x	x	—	22 (67 : 3)	—	3 (7 : 2)	—	x	x	x
1925	—	—	—	—	—	—	x	x	x	—	—	1 (2 : 2)	—	4 (8 : 2)	4 (24 : 6)	x	x

As noted, *Oikopleura* appeared in the food of the Samsø herring only in autumn. This agrees well with its occurrence in the plankton samples (Table 154).

Table 154. Oikopleura. Occurrence in plankton samples and in herring samples. Samsø.

		April	May	June	Sept.	Oct.	Nov.
Plankton samples	1923				●	⊗ ● ⊗	⊗ ⊗ ⊗
	1924	○	○ ○ ○	○	⊗ ⊗	● ● ○	
	1925	○ ○ ○	⊗ ○ ⊗		⊗ ⊗	● ● ⊗	●
Herring samples	1923				○ ○	○ ⊕ ⊕	○ ○
	1924	○	○ ○ ○	○	○ ⊕	○ ⊕ ○	
	1925	○ ○ ○	○ ○ ○		○ ○	⊕ ○ ⊕	⊕

Pisces.

The Samsø herring were not infrequently found with fish and fish eggs in the stomach contents. Out of the total of herring containing food (392), fish were found in the stomachs of 16 (4.1 %) and fish eggs in 82 (20.9 %).

Ammodytes sp. were found to the number of 17 (length 25—40 mm.) in two herring from $^{30}/_{9}$ 24.

Clupea harengus L. All the remaining fishes, as far as it was possible to judge, were larval and post-larval stages of herring. These were found in two of the autumn samples ($^{30}/_{9}$ 24 and $^{21}/_{9}$ 25). In the former sample, they appeared in 70 % of the herring with definite stomach contents, some of the herring having the stomach stuffed full of herring larvæ (see Table X, p. 138). A great number of these were so recently hatched that the yolk sac was still present. In the sample from $^{21}/_{9}$ 25, only a single herring larva was found in the stomach of a herring.

The fish eggs found in the stomachs of the herring were for by far the most part herring eggs. It often happens, when spawning herring are caught, that the nets are found to be thickly clustered with herring roe, and it is possible that the herring may have devoured a quantity of this while themselves in the nets. But as the greater part of the herring eggs found in the stomach contents had the embryo more or less developed, there can be no doubt but that these eggs were swallowed on the spawning grounds. Table 155 below shows that in spring, fish eggs were eaten chiefly in May; and in autumn, in September and early October.

Table 155. Percentages of herring containing fish eggs in the different samples. Samsø.

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	50.0 (2 : 4)	69.2 (9 : 13)	16.7 (2 : 12)	15.0 (3 : 20)	—	—	—	x
1924	x	x	—	7.1 (1 : 14)	36.8 (7 : 19)	35.3 (6 : 17)	13.3 (2 : 15)	x	x	—	55.0 (11 : 20)	50.0 (6 : 12)	16.7 (2 : 12)	—	x	x	x
1925	5.9 (1 : 17)	5.6 (1 : 18)	—	15.0 (3 : 20)	11.8 (2 : 17)	61.5 (8 : 13)	x	x	x	16.7 (2 : 12)	61.5 (8 : 13)	16.7 (2 : 12)	9.1 (1 : 11)	14.3 (2 : 14)	—	x	x

This table includes all fish eggs found in the stomach contents, but with the exception of the two samples from April 1925, where the eggs were unrecognisable, all were herring eggs. That the eggs were sometimes found in considerable numbers will be seen from Table 156.

Table 156. Average number of fish eggs, per herring containing such, in the different samples.

	April			May			June		September			October			November		
1923	x	x	x	x	x	x	x	x	x	198 (396 : 2)	13 (113 : 9)	2 (5 : 2)	2 (5 : 3)	—	—	—	x
1924	x	x	—	1 (1 : 1)	6 (42 : 7)	4 (25 : 6)	1 (3 : 2)	x	x	—	383 (4211 : 11)	5 (32 : 6)	1 (2 : 2)	—	x	x	x
1925	1 (1 : 1)	2 (2 : 1)	—	18 (54 : 3)	1 (3 : 2)	12 (100 : 8)	x	x	x	3 (7 : 2)	3 (25 : 8)	1 (3 : 2)	1 (1 : 1)	2 (4 : 2)	—	x	x

Some of the samples from September show very high averages. The sample from the end of September 1924 showed 11 herring with herring eggs in the stomach, the individual numbers differing considerably (see Table X, p. 138). The greatest number was 3410 eggs and in this case, the stomach was greatly distended by the mass of eggs. It is worth noting that in the same sample, larval and post-larval stages of herring were unusually numerous in the food. In a

few cases, spawning herring were found with herring eggs in the stomach; the greatest numbers of herring eggs, however, were found in the stomachs of immature or spent fish (maximal breadth of genital organs less than 15 mm.).

Vegetable Food.

On one occasion, a few *Zostera* leaves were found in the stomach of one of these Samsø herring; otherwise, no vegetable food was observed.

e. Concluding remarks on the food of the herring in Samsø waters.

The herring fishery at Samsø falls into two divisions, a spring and an autumn fishery, based mainly on mature fish, which at these seasons move close in to shore to spawn. The relative number of mature herring containing food was noted as 73.1 % in spring and 43.1 % in autumn, showing that the herring feed far more in spring than in autumn. Out of the total number of herring examined, crustacea were found in 92.1 % and non-crustacea in 38.5 %. The most important crustaceans were copepods, cladocerans, mysids, amphipods, cirripede larvæ and decapod larvæ, the isopods and cumacea being of but slight importance as food. Among the non-crustaceous food must be noted especially fish eggs, larval gastropods, polychætes and appendicularians, with fish and chætognaths to a lesser degree, lamellibranch larvæ and bryozoa larvæ being only exceptionally found in the food.

Here, as elsewhere in the Danish waters, copepods are the organisms most frequently found in the food, though on the whole, they appear in considerably greater numbers in spring than in autumn. The species *Pseudocalanus elongatus* and *Paracalanus parvus* together make up the most important copepod element (80.7 % of all copepods) next in order being *Temora longicornis* (14.6 %) and *Centropages hamatus* (3.0 %). Cladocerans have been noted both in spring and autumn, but never in great numbers. The genus *Podon* seems to be the commonest (92.9 % of all cladocerans). Mysids are only exceptionally found in any great number, but are far more frequent in the food in autumn than in spring. The most important species are *Schistomysis spiritus*, *Macropsis Slabberi* and *Gastrosaccus spinifer*. Among amphipods, *Gammarus locusta* is the commonest species, but none of these crustaceans is ever found in any great number. The same applies to cirripede larvæ and decapod larvæ. As regards the former, cypris stages are almost the only ones found, and the latter (*Crangon* larvæ and crab larvæ) appear mainly in autumn. Isopods (*Idothea*) are occasionally found, and a single cumacean (*Lamprops fasciata*).

Among non-crustacea, fish eggs, and especially herring eggs, appear in great numbers as herring food both in spring and autumn. Gastropod larvæ hardly ever appear in the food except in autumn, and this applies to a marked degree in the case of the appendicularians (*Oikopleura*). Polychætes, especially of the genus *Nereis*, are of some importance as food, but no great numbers were ever observed. Fish appear in the diet only in autumn, when newly-hatched herring larvæ have been found in great numbers in the stomachs of individual herring. Chætognaths (*Sagitta*) are only observed in rather small numbers in autumn, and lamellibranch larvæ and bryozoa larvæ (*Cyphonautes*) appear only exceptionally in the food of the herring from these waters.

4. Frederikshavn and Læsø Rende.

a. Material.

The material from Frederikshavn (see chart, p. 8) consists of a comparatively small number of herring, taken with stake nets (depth 7—8 metres). Only scattered samples could be obtained for investigation, and these only from autumn or the end of the summer. The total amounts to 333 herring, distributed throughout the following months of 1923—25.

September—October 1923	188	specimens
October—November 1924	82	—
July—August—September 1925	63	—

As will be seen from Table 157 most of the herring were from 17—25 cm. long, with a number of young herring from October (1923) length 12—15 cm. The former group is referred to in the following as "adult herring" in contradistinction to the young-fish. In addition to the above-mentioned material there were also 30 young herring (length 9—15 cm.) from the waters between Frederikshavn and Læsø (Læsø Rende). These fish were taken with the otter trawl in 30—32 metres of water, from the marine research vessel "Dana" on the 17th Aug. 1924, at 57° 28′ N., 10° 48′ E.

Mature fish have been found from the end of August to mid-October, but only in small numbers.

Plankton samples were taken simultaneously with the herring samples, except during the autumn of 1924, when, owing to an error, no plankton hauls were made.

Table 157. Length and number of herring examined. Frederikshavn.

cm.	July	Aug.	Sept.	Oct.	Nov.	Total
12	..	..	..	5	..	5
13	..	..	..	16	..	16
14	..	..	..	20	..	20
15	..	..	..	5	..	5
16	..	..	..	..	..	..
17	..	..	..	6	1	7
18	1	..	..	22	1	24
19	7	1	..	27	11	46
20	3	2	4	37	8	54
21	7	1	14	22	2	46
22	6	8	26	14	..	54
23	5	7	28	2	..	42
24	1	1	5	1	..	8
25	..	1	5	..	..	6

b. The relative numbers of herring containing food in the different months.

As already noted, the herring samples here cover only the period from July to November. Table 158 shows the monthly percentages of adult herring containing food.

From this it will be seen that the greatest numbers of herring containing food were found in July, whereas in November, no food was found in the specimens examined (23 in all). In the material of young herring (length 12—15 cm.) from Oct. 1923, 95.7 % had food in the stomach, whereas adult herring taken in the same month showed only 50.0 %. Evidently then, the young herring feed to a far greater extent than the adult fish. In this connection it may also be noted that food was found in all the young herring examined (30 specimens), from Læsø Rende in Aug. 1924.

Table 158. Monthly percentages of adult herring containing food. Frederikshavn.

(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined.)

	July	Aug.	Sept.	Oct.	Nov.
1923	x	x	45.7 (32 : 70)	50.0 (36 : 72)	x
1924	x	x	x	67.8 (40 : 59)	0 (0 : 23)
1925	70.0 (21 : 30)	42.9 (9 : 21)	33.3 (4 : 12)	x	x

c. Brief survey of the composition of the food.

On looking into the relative numbers of herring containing crustacea, and those with non-crustacea, we find that crustaceans are found in the food of by far the greater number of herring, as shown in Table 159, in which only adult fish are included.

Table 159. Percentages of herring containing crustaceous and non-crustaceous food in the different samples. Frederikshavn.

		1923						1924				1925				
		September			October			October			Nov.	July		August		Sept.
No. of feeding herring		11	15	6	12	7	17	15	7	18	0	13	8	3	6	4
Crustaceous food	No.	11	15	5	11	6	16	15	7	18	0	11	8	3	4	4
	%	100.0	100.0	83.3	91.7	85.7	94.1	100.0	100.0	100.0	0	84.6	100.0	100.0	66.7	100.0
Non-crustaceous food	No.	3	0	2	6	3	3	8	1	14	0	7	1	2	4	0
	%	27.3	0	33.3	50.0	42.9	17.6	53.3	14.3	77.8	0	53.8	12.5	66.7	66.7	0

Out of the total of 142 containing food, crustacea were found in 134 (94.4 %), and non-crustacea in 54 only (38.0 %).

As mentioned, there were some young herring from October 1923, and it may be interesting to consider the proportions for crustacea and non-crustacea in these as compared with adult fish from the same month (Table 160).

Table 160. Crustacea and non-crustacea in young herring compared with adult herring, weighted by the percentage of feeding herring. Frederikshavn Oct. 1923.

	Crustacea			Non-crustacea			Total	
Date	12/10	21/10	30/10	12/10	21/10	30/10	Crustacea	Non-crustacea
Young herring (12—15 cm. length)	100.0 (5:5)	91.4 (32:35)	100.0 (4:4)	60.0 (3:5)	85.7 (30:35)	75.0 (3:4)	93.2	81.8
Adult herring (17—24 cm. length)	91.7 (11:12)	85.7 (6:7)	94.1 (16:17)	50.0 (6:12)	42.9 (3:7)	17.6 (3:17)	91.7	33.3

The numbers of young herring and of adult fish containing crustacea were about equal; non-crustacea on the other hand were found in far greater numbers of the young herring than of the adults. As will be seen in the following, this difference must be due mainly to the fact that the young herring feed on larval gastropods to a far greater extent than do the adults (see Table 163). Out of the 30 young herring from Læsø Rende, crustacea were found in 29 (96.7 %) and non-crustacea in 18 (60.0 %).

The table below shows the percentages of adult fish containing the various groups of organisms.

Table 161. Percentages of adult herring containing the various groups of organisms, calculated from the total number of feeding herring in the respective samples. Frederikshavn.

	1923						1924				1925				
	September			October			October			Nov.	July		August		Sept.
Copepoda	100.0	100.0	33.3	75.0	71.4	88.2	93.3	42.9	88.9	—	38.5	75.0	100.0	66.7	50.0
Cladocera	—	6.7	33.3	—	—	—	6.7	—	—	—	30.8	—	—	16.7	—
Mysidacea	—	—	—	—	—	—	—	—	—	—	7.7	—		—	—
Amphipoda	9.1	6.7	33.3	16.7	—	11.8	46.7	71.4	16.7	—	38.5	12.5	—	—	
Isopoda	—	—	—	—	14.3	5.9	46.7	57.1	—	—	—	12.5	—	—	—
Cirripedia	—	—	—	—	—	—	—	—	61.1	—	—	—	—	—	—
Decapoda	36.4	26.7	—	66.7	14.3	5.9	—	—	—	—	30.8	50.0	66.7	16.7	75.0
Cumacea	—	—	—	—	—	—	6.7	—	—	—	—	—	—	—	
Polychæta	—	—	—	—	—	5.9	6.7	—	5.6	—	46.2	—	—	—	—
Gastropoda	—	—	16.7	—	42.9	5.9	33.3	14.3	50.0	—	—	—	66.7	16.7	—
Chætognatha	—	—	—	25.0	—	—	—	—	11.1	—	—	—	—	33.3	—
Appendiculariæ	27.3	—	—	8.3	—	—	6.7	—	50.0	—	—	—	—	16.7	—
Pisces	—	—	16.7	16.7	—	—	6.7	—	—	—	7.7	12.5	—	16.7	—
Pisces ova	—	—	—	—	—	5.9	—	—	—	—	—	—	—	—	—

This table shows that in most samples, copepods were found in a considerable number of herring during the months of July, August, September and October. The November material (23 specimens) contained, as already mentioned, no fish with definite stomach contents. Cladocerans have never been found in any great number of herring, and never later than early October. Amphipods appeared in fairly considerable numbers in the samples from July, but these organisms, like the isopods, were also found chiefly in October. Cirripede larvæ were only observed in a single sample, from Oct. 1924; in this however, no fewer than 61.1 % of the herring examined contained larvæ of this group. Decapod larvæ were fairly numerous in most of the samples.

Among non-crustacea, polychætes appeared in a comparatively large number of herring (46.2 %) in the middle of July, otherwise only in a fish or so here and there. Larval gastropods were noted from mid-August to the end of October, often in a considerable number of the fish. Chætognaths and appendicularians appeared in several of the samples during about the same period. The number of herring with fish remains in the stomach was always small.

Table 162. Mean monthly percentage of herring containing the different groups of organisms. Frederikshavn.

	July	Aug.	Sept.	Oct.	Nov.
Copepoda	52.4	77.8	68.7	81.5	—
Cladocera	19.0	11.1	4.7	1.2	—
Mysidacea	4.8	—	—	—	—
Amphipoda	28.6	—	6.2	24.3	—
Isopoda	4.8	—	—	16.5	—
Cirripedia	—	—	—	14.5	—
Decapoda	38.1	33.3	50.0	13.9	—
Cumacea	—	—	—	1.2	—
Polychæta	28.6	—	—	3.9	—
Gastropoda	—	33.3	1.5	24.3	—
Chætognatha	—	22.2	—	6.6	—
Appendiculariæ	—	11.1	4.7	13.9	—
Pisces	9.5	11.1	1.5	4.0	—
Pisces ova	—	—	—	1.4	—

Taking the material for the separate months and calculating the average for the monthly values, we obtain the result given in Table 162.

The above calculations are based exclusively on the material of adult herring. Since we have a sample of young herring from Oct. 1923, it will be interesting to compare the results of these stomach analyses with those of the adult fish from the same month (see Table 163).

The total number of herring with definite stomach contents in Oct. 1923 amounted to 44 young fish and 36 adults.

The most conspicuous difference in the composition of the food appeared in the case of the gastropods. Larval gastropods were found in 79.5 % of the young herring, but only in 11.1 % of the adults, showing that the young herring feed on gastropod larvæ to a far greater extent than do the adult fish.

Table 163. Percentages of young herring containing the different groups of organisms compared with those of adult fish. Frederikshavn October 1923.

(Figures in parentheses indicate number of herring containing the various organisms.)

	Copepoda	Cladocera	Amphipoda	Isopoda	Cirripedia	Decapoda	Polychæta	Gastropoda	Lamellibr.	Chætognatha	Appendicul.	Pisces	Pisces ova.
Young herring (12—15 cm. length)	84.1 (37)	9.1 (4)	6.8 (3)	6.8 (3)	4.5 (2)	9.1 (4)	—	79.5 (35)	2.3 (1)	—	13.6 (6)	4.5 (2)	—
Adult herring (17—24 cm. length)	80.6 (29)	—	11.1 (4)	5.6 (2)	—	27.8 (10)	2.8 (1)	11.1 (4)	—	8.3 (3)	2.8 (1)	5.6 (2)	2.8 (1)

There was also, as above mentioned, a sample of 30 young herring from Læsø Rende (Aug. 1924). As these were taken over considerably deeper water (30—32 metres) than the stake net herring, direct comparison with the remaining material can hardly be made. Table 164 shows the relative numbers of herring containing the different groups of organisms.

Table 164. Percentages of herring containing the different groups of organisms. Læsø Rende $^{17}/_{8}$ 1924.

(Figures in parentheses indicate number of herring containing the various organisms).

Copepoda	Cladocera	Cirripedia	Decapoda	Lamellibranchiata	Chætognatha	Pisces ova	Diatoms
96.7 %	6.7 %	6.7 %	70.0 %	3.3 %	16.7 %	16.7 %	43.3 %
(29)	(2)	(2)	(21)	(1)	(5)	(5)	(13)

It is particularly interesting to note that larval decapods appeared in the food of no fewer than 70.0 % of the herring, and that diatoms (of the genus *Coscinodiscus*) were found in 43.3 %. This latter fact indicates that phytoplankton can at times be of some importance as food for young herring.

d. Systematic survey of the occurrence of the different organisms in the food.

In the following systematic survey of the organisms found in the food of the herring from Frederikshavn, attention has been paid primarily to the material of adult herring; in several cases, however, comparison has also been made between the occurrence of the different organisms in the food of young herring and in that of the adult fish. Finally, the occurrence of the various organisms in the food of the young herring from Læsø Rende 17th Aug. 1924 is also noted. For explanation of tables see p. 11.

Cladocera.

Cladocerans were only noted in small quantities in the food of the herring. The number of herring containing cladocerans decreased from July to October (see Table 162). In the adult herring, not more than 1—2 specimens per fish have been noted, whereas in 4 young herring from early Oct. 1923, 1, 10, 12 and 14 specimens were recorded, suggesting that young herring feed more on cladocerans than do the adults. The following species have been identified with certainty:

Evadne Nordmanni Lovén
Evadne spinifera P. E. Müller
Podon intermedius Lillj.

Out of the total number of specimens found in the stomach analyses, 10 belonged to the genus *Evadne* and 77 to the genus *Podon*.

Both genera appeared in most of the plankton samples from 1923 and 1925. The species *Evadne Nordmanni* and, to a lesser degree, *Evadne spinifera*, were in one month (July 1925) observed in considerable numbers; *Podon intermedius* on the other hand occurred in small numbers throughout.

Copepoda.

Copepods are the organisms found in greatest numbers in the food. As shown in Table 165 they appeared in all samples save that from November.

Table 165. Percentages of herring containing copepods in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	100.0 (11 : 11)	100.0 (15 : 15)	33.3 (2 : 6)	75.0 (9 : 12)	71.4 (5 : 7)	88.2 (15 : 17)	x	x
1924	x	x	x	x	x	x	x	x	93.3 (14 : 15)	42.9 (3 : 7)	88.9 (16 : 18)	—	x
1925	38.5 (5 : 13)	75.0 (6 : 8)	x	100.0 (3 : 3)	66.7 (4 : 6)	50.0 (2 : 4)	x	x	x	x	x	x	x

Table 166 shows the average number of copepods per herring containing such.

Table 166. Average number of copepods, per herring containing such, in the different samples.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	3 (35 : 11)	20 (295 : 15)	2 (4 : 2)	5 (44 : 9)	3 (16 : 5)	2 (34 : 15)	x	x
1924	x	x	x	x	x	x	x	x	10 (141 : 14)	1 (3 : 3)	6 (95 : 16)	—	x
1925	3 (16 : 5)	2 (10 : 6)	x	8 (24 : 3)	18 (74 : 4)	1 (2 : 2)	x	x	x	x	x	x	x

It will be noted that copepods were never found in great numbers in the adult herring from Frederikshavn during summer and autumn. Turning to the young herring however, we find a different state of things. In 37 young herring from Oct. 1923 for instance, the average number of copepods per fish was 45, whereas 29 adult herring from the same month showed an average of 3. In this connection, it may further be noted that the average number of copepods for young herring from Læsø Rende Aug. 1924 worked out at 48. It is thus evident that in autumn, the young herring feed on copepods to a far greater extent than do the adults.

The following copepods have been found in the food of the herring from Frederikshavn and Læsø Rende:

Calanus finmarchicus (Gunner.)
Pseudocalanus elongatus Boeck
Paracalanus parvus Claus
Centropages typicus Krøyer
Centropages hamatus (Lillj.)
Isias clavipes Boeck
Temora longicornis (O. F. Müller)
Anomalocera Patersoni Templeton
Labidocera Wollastoni Lubbock
Acartia longiremis (Lillj.)
Acartia Clausi Giesbrecht
Oithona similis Claus
Microsetella norvegica (Boeck)
Corycæus anglicus Lubbock.

In the following, the species *Pseudocalanus elongatus* and *Paracalanus parvus* are taken together, the two species of the genus *Acartia* being likewise taken under one head. In the stomach analyses, besides the species *Microsetella norvegica*, some other harpacticids were also found, but these it was not possible to identify further.

The numbers of the different copepods found in the stomach analyses, and the percentages of the whole, are shown in Table 167 which gives the number of copepods 1) in the total material of adult herring from Frederikshavn (July—Oct. 1923—25), 2) in young herring from Frederikshavn (Oct. 1923) and 3) in young herring from Læsø Rende (Aug. 1924).

Table 167. Relative importance of the various copepods as food for adult herring from Frederikshavn and young herring from Frederikshavn and Læsø Rende.

	Adult herring (17—25 cm.) Frederikshavn July—Oct. 1923—25		Young herring (12—15 cm.) Frederikshavn Oct. 1923		Young herring (9—15 cm.) Læsø Rende 17/8 1924	
	No.	%	No.	%	No.	%
Calanus finmarchicus	38	5.5	23	1.9	4	0.3
Pseudocalanus + Paracalanus	134	19.4	628	51.4	261	20.2
Centropages typicus	40	5.8	—	—	—	—
Centropages hamatus	289	41.8	76	6.2	7	0.5
Isias clavipes	4	0.6	4	0.3	3	0.2
Temora longicornis	118	17.1	145	11.9	950	73.4
Anomalocera Patersoni	2	0.3	—	—	—	—
Labidocera Wollastoni	18	2.6	2	0.2	—	—
Acartia sp.	26	3.8	147	12.1	59	4.6
Oithona sp.	3	0.4	4	0.3	1	0.1
Harpacticidæ	12	1.7	72	5.9	9	0.7
Corycæus anglicus	7	1.0	120	9.8	—	—

For the adult herring, *Centropages hamatus*, *Pseudocalanus* + *Paracalanus* and *Temora* are the most important species. The young herring from Frederikshavn show a numerical predominance of *Pseudocalanus* + *Paracalanus*, *Acartia* and *Temora* being of minor importance. The last-named species is however, by far the most important copepod in the food of the young herring from Læsø Rende, though *Pseudocalanus* + *Paracalanus* also appear in considerable numbers.

We will then consider the relative number of herring containing the different copepods. Table 168 shows the percentages, divided into three groups as in the table above.

It will be noted at once that the various copepods are found on the whole in a far greater number of fish among the young herring than among the adults, *Pseudocalanus* + *Paracalanus* however, with *Temora*, being the copepods most frequently found in all three groups. Some differences appear in the percentages for young herring from Frederikshavn and Læsø Rende; it may be noted, for instance, that the species *Corycæus anglicus* appears in the food of 20.5 % of the young herring from Frederikshavn, but is not found at all in the stomachs of young herring from Læsø Rende.

Finally, we will consider the average numbers of the most important copepods noted per fish during the different months. Table 169 shows the averages for adult herring from Frederikshavn, as also for the young herring from the same locality (Oct. 1923), and young herring from Læsø Rende (Aug. 1924).

It will be noted that the averages for the months here concerned are as a rule very low for adult herring. An exception is observed in the case of *Centropages hamatus* for Sept. 1923 (38 specimens per fish). Comparing the averages for adult herring and young fish from Oct. 1923, it will be seen that all the copepods noted are found in

Table 168. Percentages of herring containing the different copepods; samples comprising adult herring from Frederikshavn, young herring from Frederikshavn and young herring from Læsø Rende.

(Figures in parentheses indicate the number of herring containing the respective copepods).

	Adult herring Frederikshavn July—Oct. 1923—25	Young herring Frederikshavn Oct. 1923	Young herring Læsø Rende 17/8 1924
No. of feeding herring	142	44	30
Calanus finmarchicus	14.1 % (20)	6.8 % (3)	13.3 % (4)
Pseudocalanus + Paracalanus	33.8 - (48)	70.5 - (31)	83.3 - (25)
Centropages typicus	4.9 - (7)	— -	— -
Centropages hamatus	19.7 - (28)	50.0 - (22)	16.7 - (5)
Isias clavipes	2.8 - (4)	2.3 - (1)	6.7 - (2)
Temora longicornis	36.6 - (52)	52.3 - (23)	83.3 - (25)
Anomalocera Patersoni	1.4 - (2)	— -	— -
Labidocera Wollastoni	5.6 - (8)	4.5 - (2)	— -
Acartia sp.	15.5 - (22)	34.1 - (15)	56.7 - (17)
Oithona sp.	2.1 - (3)	6.8 - (3)	3.3 - (1)
Harpacticidæ	6.3 - (9)	25.0 - (11)	20.0 - (6)
Corycæus anglicus	4.9 - (7)	20.5 - (9)	— -

considerably greater numbers in the young herring than in the adults. The stomach analyses of young herring from Læsø Rende show that, as previously indicated, *Temora longicornis* is the most important copepod in the food of these fish.

Table 169. Monthly averages for the principal copepods, showing number of specimens per herring containing the respective species.

	Adult herring (Length 17—25 cm.)						Young herring (Length 9—15 cm.)	
	Frederikshavn						Frederiks-havn	Læsø Rende
	1923		1924	1925			1923	1924
	Sept.	Oct.	Oct.	July	Aug.	Sept.	Oct.	Aug.
Calanus finmarchicus	1 (1 : 1)	3 (19 : 7)	2 (15 : 9)	1 (2 : 2)	1 (1 : 1)	—	8 (23 : 3)	1 (4 : 4)
Pseudocalanus + Paracalanus	2 (23 : 12)	2 (8 : 5)	4 (91 : 24)	3 (8 : 3)	1 (3 : 3)	1 (1 : 1)	20 (628 : 31)	10 (261 : 25)
Centropages hamatus	38 (229 : 6)	1 (6 : 6)	3 (54 : 16)	—	—	—	3 (76 : 22)	1 (7 : 5)
Temora longicornis	2 (21 : 13)	1 (11 : 9)	3 (50 : 15)	1 (11 : 8)	4 (25 : 7)	—	6 (145 : 23)	38 (950 : 25)
Acartia sp.	1 (11 : 9)	1 (4 : 4)	1 (11 : 9)	—	—	—	10 (147 : 15)	3 (59 : 17)

Calanus finmarchicus. In some of the samples, this species was found in a considerable number of fish (Table 170, p. 88). The average number per fish was small throughout, varying from 1 to 3 for the different samples; the greatest number found in the stomach of a single fish was 6. Among the young herring from Frederikshavn and Læsø Rende, the species was only found in a few of the fish examined. In the plankton samples, the species was noted only in very small numbers.

Pseudocalanus elongatus + Paracalanus parvus, which are among the most important species in the food of the herring from Frederikshavn, were found in the percentages of the fish examined, as shown in Table 171.

Table 170. Percentages of herring containing Calanus finmarchicus in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	—	6.7 (1:15)	—	58.3 (7:12)	—	—	x	x
1924	x	x	x	x	x	x	x	x	53.3 (8:15)	14.3 (1:7)	—	—	x
1925	7.7 (1:13)	12.5 (1:8)	x	33.3 (1:3)	—	—	x	x	x	x	x	x	x

Table 171. Percentages of herring containing Pseudocalanus + Paracalanus in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	45.5 (5:11)	40.0 (6:15)	16.7 (1:6)	8.3 (1:12)	42.9 (3:7)	5.9 (1:17)	x	x
1924	x	x	x	x	x	x	x	x	53.3 (8:15)	14.3 (1:7)	83.3 (15:18)	—	x
1925	7.7 (1:13)	25.0 (2:8)	x	33.3 (1:3)	33.3 (2:6)	25.0 (1:4)	x	x	x	x	x	x	x

It will be noted that the species appeared in all the samples examined (except for November). The average number per fish in the different samples varied from 1 to 6. Among the young herring, these species were relatively far more important as an article of food. The young herring from Frederikshavn for instance showed 70.5 % containing these, and the young herring from Læsø Rende 83.3 %. The averages here were 20 and 10 specimens per fish respectively. Both species appeared in all the plankton samples examined from July to October (1923 and 1925) generally in considerable numbers. *Paracalanus* however, was especially numerous in the autumn months.

Centropages typicus was only noted in two herring samples from Aug. 1925, but was then relatively numerous, appearing in 7 out of 9 fish containing food. The average per fish was 6 (maximum 14). In the plankton samples, the species was noted as common in Aug. 1925; single specimens were also found at the end of July and in early September of the same year.

Centropages hamatus was only found in the food in the months of September and October.

Table 172. Percentages of herring containing Centropages hamatus in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	—	40.0 (6:15)	—	—	14.3 (1:7)	29.4 (5:17)	x	x
1924	x	x	x	x	x	x	x	x	53.3 (8:15)	—	44.4 (8:18)	—	x
1925	—	—	x	—	—	—	x	x	x	x	x	x	x

This species, like most other copepods, appeared in the food of a larger number of young herring than of adults. The three samples of young herring from Frederikshavn for instance (Oct. 1923) showed the following percentages: 60.0, 48.6 and 50.0 %. In the various samples of adult herring, the averages for this species varied rather considerably. The samples from Sept. 1923 for instance, showed 38 per fish (maximum 102). In the samples from October, the averages varied between 1 and 6. Among the young herring from Frederikshavn and Læsø Rende, the averages were 3 and 1 per fish respectively. The plankton sample from mid-Sept. 1923 contained a great number of specimens; otherwise, the species was noted only in small numbers.

Isias clavipes. Single specimens of this species were found in the food of adult herring in the samples from July, August and September, and also in small numbers in the stomach contents of the young herring. In the plankton samples, the species appeared, though in small numbers, from mid-July to the end of September.

Temora longicornis. This species was found both in the summer and autumn in the stomachs of a considerable number of fish.

Table 173. Percentages of herring containing Temora longicornis in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	54.5 (6:11)	46.7 (7:15)	—	25.0 (3:12)	14.3 (1:7)	29.4 (5:17)	x	x
1924	x	x	x	x	x	x	x	x	53.3 (8:15)	14.3 (1:7)	33.3 (6:18)	—	x
1925	30.8 (4:13)	50.0 (4:8)	x	100.0 (3:3)	66.7 (4:6)	—	x	x	x	x	x	x	x

In the food of the adult herring, however, only small numbers of this species were noted. The average for the different samples varied between 1 and 5 per fish (maximum 12). Among the young herring from Frederikshavn (Oct. 1923) *Temora* was noted in 52.3 % with an average of 6 per fish, the young herring from Læsø Rende (Aug. 1924) showing 83.3 % with an average of 38 specimens per fish. In most of the plankton samples *Temora* was found in considerable numbers, but was in all cases less numerous than the two species *Pseudocalanus elongatus* and *Paracalanus parvus*.

Anomalocera Patersoni. Single specimens of this species were found in two adult herring ($^{15}/_{7}$ 25). A few specimens were noted in the plankton, also in July.

Labidocera Wollastoni was only observed in the food in October. Among the adult herring, it appeared in a single sample from $^{12}/_{10}$ 24. Eighteen specimens were then found in 8 out of 15 fish (53.3 %). Single specimens were also found in the food of two young herring from Frederikshavn. A few specimens of this species were observed in the plankton samples from Oct. 1923 and Aug. 1925.

Acartia sp. The genus *Acartia* appeared several times in the food, but among the adult fish only in September and October (Table 174).

Table 174. Percentages of herring containing Acartia in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	—	60.0 (9:15)	—	8.3 (1:12)	—	17.6 (3:17)	x	x
1924	x	x	x	x	x	x	x	x	20.0 (3:15)	—	33.3 (6:18)	—	x
1925	—	—	x	—	—	—	x	x	x	x	x	x	x

The greatest number of *Acartia* found in the stomach contents of the adult fish was 3; young herring from Frederikshavn on the other hand were found to contain up to 69 (average 10 per fish) and young herring from Læsø Rende up to 12 per fish (average 3). The only two species identified with certainty in the stomach analyses were *A. longiremis* and *A. Clausi.* Both were noted in all the plankton samples, the former however, as a rule being somewhat more numerous than the latter.

Oithona sp. Single specimens of the genus *Oithona* were found in a few herring, and the value of these copepods as food was altogether insignificant. The species *O. similis* appeared in all the plankton samples from these waters, but only in small numbers.

Harpacticidæ. Harpacticids were found, in small numbers, in the food of the adult herring, but were relatively more numerous among the young fish. The only species which could be identified with certainty was *Microsetella norvegica.* In the plankton samples, only *Microsetella norvegica* was noted, and this in single specimens only from Aug., Sept. and October.

Corycæus anglicus was found in greater numbers among the food of the young herring than in that of the adults. Among the adults it was noted in Oct. 1923 in 7 out of 36 fish (19.4 %) with an average of 1 per fish; in young herring from the same month it was found in 9 specimens out of 44 (20.5 %) with an average of 13 per fish. In the plankton samples, the species was noted in Sept. and October, but only in rather small numbers.

Cirripedia.

Among the adult herring, cirripede larvæ appeared in a single sample, $^{30}/_{10}$ 24, 26 specimens being found in the stomachs of 11 fish, representing 61.1 % of the herring examined. Single specimens were also found in a few young

herring. Of the larval cirripedes noted in the stomach analyses, 10 were nauplii and 20 cypris stages. Only small numbers of larval cirripedes were observed in the plankton samples.

Mysidacea.

The mysids were of altogether subordinate importance as food for the herring from Frederikshavn. Only a single fish was found to contain these, 4 specimens of *Schistomysis spiritus* Norm. being found in the stomach of a herring from $^{15}/_{7}$ 25.

Decapoda.

Taking the decapods together, without regard to species or stage of development, it will be seen (Table 175) that these crustacea often appeared in the food of a considerable number of herring.

Table 175. Percentages of herring containing decapods in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	36.4 (4:11)	26.7 (4:15)	—	66.7 (8:12)	14.3 (1:7)	5.9 (1:17)	x	x
1924	x	x	x	x	x	x	x	x	—	—	—	—	x
1925	30.8 (4:13)	50.0 (4:8)	x	66.7 (2:3)	16.7 (1:6)	75.0 (3:4)	x	x	x	x	x	x	x

The majority of the decapods found in the stomachs of these herring were crab larvæ. The average per fish in the different samples varied from 1 to 6, with the exception of one sample from Sept. 1925, which showed an average of 18, due mainly to the presence of one herring containing 50 crab larvæ. Most of the crab larvæ were larval stages of *Carcinus mœnas* (L.) and *Cancer pagurus* L. The samples from Oct. 1923 and Sept. 1925 also contained a few zoea stages of *Pinnotheres pisum* (L.). In the young herring from Frederikshavn (Oct. 1923) 11 crab larvæ were found in all, and these all belonged to the last-named species. Young herring from Læsø Rende (Aug. 1924) contained considerable numbers of *Eupagurus* larvæ, which appeared in the stomachs of 70 % of the herring examined, the average per fish being 16. One herring was found to contain no fewer than 82 *Eupagurus* larvæ; the plankton sample from Læsø Rende also contained considerable numbers of these. Other identifiable decapods noted in the stomach analyses from Frederikshavn were the following:

Nephrops norvegicus (L.). A larval stage of this species was found on the $^{12}/_{10}$ 23.

Crangon sp. Crangon larvæ were repeatedly observed in the food during the months covered by the investigations, but only in small numbers. Single specimens appeared in the plankton samples for Aug., Sept. and October.

Hippolyte varians Leach. Young specimens were found singly in two herring ($^{15}/_{7}$ 25).

Palæmon Fabricii Rathke. Single specimens were found on the $^{20}/_{9}$ 23 and $^{15}/_{7}$ 25.

Cumacea.

A solitary specimen of the species *Pseudocuma longicorne* (Sp. Bate) was found in the stomach of a herring $^{12}/_{10}$ 24.

Isopoda.

All the isopods found in the food belonged to the genus *Idothea.* As only young specimens were observed, it was impossible to determine species with certainty. As will be seen from Table 176, *Idothea* was found in the food only in October, save for a single occasion in July.

Table 176. Percentages of herring containing Idothea in the different samples. Frederikshavn.

	July		Aug.			Sept			Oct.			Nov.	
1923	x	x	x	x	x	—	—	—	—	14.3 (1:7)	5.9 (1:17)	x	x
1924	x	x	x	x	x	x	x	x	46.7 (7:15)	57.1 (4:7)	—	—	x
1925	—	12.5 (1:8)	x	—	—	—	x	x	x	x	x	x	x

In the October samples, the average number of *Idothea* per fish was 5. This comparatively high figure is due to the fact that one herring ($^{21}/_{10}$ 24) contained 24 specimens.

Amphipoda.

Amphipods appeared fairly frequently in the food of a considerable number of herring (Table 177).

Table 177. Percentages of herring containing amphipods in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	9.1 (1:11)	6.7 (1:15)	33.3 (2:6)	16.7 (2:12)	—	11.8 (2:17)	x	x
1924	x	x	x	x	x	x	x	x	46.7 (7:15)	71.4 (5:7)	16.7 (3:18)	—	x
1925	38.5 (5:13)	12.5 (1:8)	x	—	—	—	x	x	x	x	x	x	x

The number of amphipods found in the stomach contents was rarely large, though a single fish from Oct. 1924 was found to contain 40 specimens. Save for the sample in which this one appeared, which had an average of 8 per fish, the samples showed averages ranging from 1 to 3. The following species were identified:

Hyperia galba (Mont.) 8 specimens in 4 herring from $^{15}/_{7}$ 25.

Themisto abyssorum (Boeck) 4 specimens on the same date in 2 fish.

Nototropis sp. The species *N. Swammerdami* (M.-Edw.) was identified with certainty (two specimens) $^{30}/_{10}$ 23. A specimen from $^{29}/_{9}$ 23 probably belonged to the species *N. falcatus* (Metzg.).

Gammarus locusta L. was by far the commonest species in the food. Of the comparatively large number of amphipods noted in Oct. 1924, the majority belonged to this species.

Ischyrocerus anguipes Krøyer was found in a sample from $^{15}/_{7}$ 25 (two specimens); the same sample also contained an individual presumably belonging to the species *I. megalops* G. O. Sars.

Polychæta.

The number of herring containing polychætes was comparatively small. In a sample from $^{15}/_{7}$ 25, polychætes were found in 46.2 % of the herring investigated (6 herring: 17 polychætes); otherwise, only single specimens were noted. The following species were identified with certainty:

Nereis pelagica L. One specimen was found on the $^{30}/_{10}$ 23, and several $^{15}/_{7}$ 25.

Tomopteris helgolandica Greeff. A single specimen was found $^{12}/_{10}$ 24.

Gastropoda.

Larval gastropods often appeared in a considerable number of the autumn herring examined, as will be seen from the table below.

Table 178. Percentages of herring containing larval gastropods in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	—	—	16.7 (1:6)	—	42.9 (3:7)	5.9 (1:17)	x	x
1924	x	x	x	x	x	x	x	x	33.3 (5:15)	14.3 (1:7)	50.0 (9:18)	—	x
1925	—	—	x	66.7 (2:3)	16.7 (1:6)	—	x	x	x	x	x	x	x

The average number per fish was particularly high in the sample from mid-Oct. 1923, viz. 18; in the remaining samples, averages ranged from 1 to 8 per fish.

It is interesting to compare the occurrence of larval gastropods in the stomach contents of young herring and of adults in Oct. 1923. As already shown in Table 163 (p. 84) larval gastropods appeared during this month in 79.5 % of the young herring examined, but only in 11.1 % of the adults. This shows that the young herring feed to

a far greater extent on larval gastropods than do the adults. A detailed survey of the numbers of gastropod larvæ found in young herring from Oct. 1923 will be found in Tables XIV–XVI (p. 139) showing the considerable numbers found in the food. A further illustration of the fact that the younger herring especially live on larval gastropods is given in Fig. 6. From this it will be seen that only the smallest specimens of the adult herring (length over 17 cm.) contained larval gastropods.

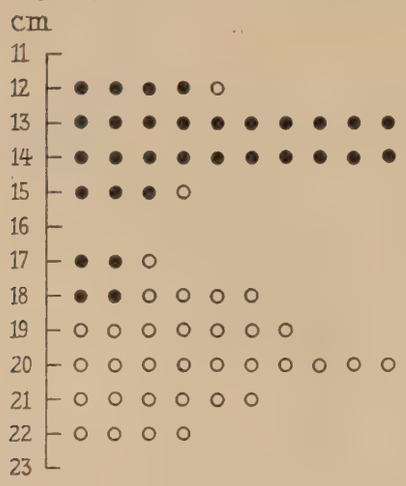


Fig. 6. Total lengths of herring with definite stomach contents showing fish containing larval gastropods. Frederikshavn, Oct. 1923.

Larval gastropods were noted in all the available plankton samples from July to October, on the whole in rather small numbers, but with a pronounced maximum in October.

Lamellibranchiata.

Lamellibranch larvæ were found only in two young herring (6 specimens). Small numbers were noted in the plankton samples from Aug., Sept. and October.

Chætognatha.

Sagitta was found in 7 adult fish, total number of specimens 8. Young herring from Læsø Rende (Aug. 1924) included 5 containing *Sagitta*, percentage 16.7 %, total number of specimens 24. From July to October, *Sagitta* appeared in most of the plankton samples, in some of which it must be said to be common. Nevertheless, as appears from the above, its importance as food for the herring was but slight.

Appendiculariæ.

The only genus of appendicularians found in the food was *Oikopleura*. The species *O. dioica* Fol. was common in the plankton samples, the greatest numbers being noted in Sept. and October. Table 179 shows the relative numbers of herring containing *Oikopleura*.

Table 179. Percentages of herring containing Oikopleura in the different samples. Frederikshavn.

	July		Aug.			Sept.			Oct.			Nov.	
1923	x	x	x	x	x	27.3 (3:11)	—	—	8.3 (1:12)	—	—	x	x
1924	x	x	x	x	x	x	x	x	6.7 (1:15)	—	50.0 (9:18)	—	x
1925	—	—	x	—	16.7 (1:6)	—	x	x	x	x	x	x	x

In the sample from the end of Oct. 1924, *Oikopleura* was found in 50 % of the herring examined, with an average of 11 per fish (maximum 35), the averages for the remaining samples being quite low. *Oikopleura* appeared in the food of 13.6 % of the young herring from Oct. 1923.

Pisces.

Remains of fish were found in 6 herring samples from mid-July to early October, but only a small percentage of the herring in each sample contained such food (6.7 %—16.7 %). One herring from $^{12}/_{10}$ 23 contained 20 young *Ammodytes sp.* and one from $^{12}/_{10}$ 24 had 8 of the same genus; save for these two cases, however, only single indeterminable specimens of fish were noted in the stomach contents.

Fish eggs were of but very slight importance as herring food during the months covered by these investigations. Of the stake net herring from Frederikshavn, only one was found with 5 fish eggs in the stomach; young herring from Læsø Rende on the other hand showed 5 out of 30 with fish eggs to the number of 1—2 per fish. None of the eggs could be identified.

Vegetable Food.

A few of the stake net herring from Frederikshavn were found to contain some small remains of vegetable matter (algæ, *Zostera*); young herring from Læsø Rende (Aug. 1924) on the other hand showed a fairly regular and

pronounced occurrence of diatoms in the food, belonging to the genus *Coscinodiscus*. Several of the fish contained great numbers of these diatoms, from about 50 to 200 specimens, and there can thus be little doubt that the herring had been actually and directly feeding on them. Out of 30 herring, *Coscinodiscus* was found in 13, or 43.3 %. This investigation shows that diatoms may at times be found to be of some importance as food for young herring. In the plankton samples from Læsø Rende, the species *Coscinodiscus radiatus* Ehbg. and *Coscinodiscus iridis* Ehbg. were noted as fairly numerous.

e. Concluding remarks on the food of the herring from Frederikshavn and Læsø Rende.

The present material consists of stake net herring from Frederikshavn together with a sample of young herring taken in the otter trawl in Læsø Rende (Aug. 1924). Samples of stake net herring are available only from the summer and autumn months (July—Nov.) and the following observations therefore apply only to herring from these seasons.

Young herring (length 12—15 cm.) feed to a far greater extent than do the adults (length 17—25 cm.). In Oct. 1923 for instance, food was found in 95.7 % of the young herring examined from Frederikshavn, but only in 50 % of the adults examined. Young herring from Læsø Rende (Aug. 1924) showed 100 % positive stomach contents. Taking the total number of adult herring, crustacea were found in 94.4 % and non-crustacea in 38.0 %. In Oct. 1923, crustaceous food was found in 93.2 % of young herring and in 91.7 % of adults, non-crustaceous food in 81.8 % young herring and 33.3 % adults, showing that non-crustacea were far more important as food for the young herring than for the adults. The most important crustacea were copepods, cladocerans, amphipods and decapods; mysids, isopods, cirripede larvæ and cumacea on the other hand were of subordinate importance. Among non-crustacea may be noted especially larval gastropods, appendicularians and fishes; but polychætes, chætognaths, lamellibranch larvæ and fish eggs have also been found in the food. Finally, it should be mentioned that diatoms (*Coscinodiscus*) were found as food in 43.3 % of the young herring from Læsø Rende.

Copepods appear in the food on the whole in far greater numbers among the young herring than among the adults. The principal species are *Pseudocalanus + Paracalanus, Temora longicornis* and *Centropages hamatus*, other copepods being of rather slight importance. Among the cladocerans, the genera *Evadne* and *Podon* are found in relatively small numbers. The last-named genus furnishes 88.5 % of all cladocerans found in the stomach analyses. Amphipods are of considerable importance in the food, the commonest species being *Gammarus locusta*. Of the decapods, crab larvæ are found in great numbers. *Crangon* larvæ also however, being fairly common in the food, and young herring from Læsø Rende contain considerable numbers of *Eupagurus* larvæ. Mysids (*Schistomysis spiritus*) are only found in a single fish; isopods (*Idothea*) on the other hand appear in the food of a considerable number of herring in October. Cirripede larvæ are of slight importance for the herring in autumn, and as regards cumacea, only a single specimen (*Pseudocuma longicorne*) is found.

Of the non-crustacea, larval gastropods are found in considerable numbers in the food of the herring in autumn, but on the whole, in far greater quantity among the young herring than among the adults. Appendicularians (*Oikopleura*) are not uncommon, but are rarely numerous. The same may be said of fishes, of which the genus *Ammodytes* especially has been found in the food. Polychætes are of rather slight importance, and the same applies in even higher degree to chætognaths (*Sagitta*), lamellibranch larvæ and fish eggs.

5. Groves Flak, Kattegat.

In the neighbourhood of Groves Flak, SE of Læsø (see chart, p. 8), on the 7th October 1922, a sample of herring caught by purse seine was examined immediately after capture. The fish were almost exclusively spawning or spents (degree of maturity V—VII, cf. Johansen 1924, p. 4). Of these, 65 (39 of V—VI maturity, 26 of VII) were examined, 58 of which were found to have no food in the stomach. The remainder, including 5 of the VII degree maturity, had a few (1—8) copepods. This investigation shows

that the herring spawning in autumn in this part of the Kattegat had, during the spawning period and immediately after, either no food at all, or very little in the stomach.

On examining the degree of maturity of a great number of the herring captured, 15 immature specimens (degree of maturity II—III) were obtained, the total lengths being 19—24 cm. The stomach analyses of these showed that all had considerable quantities of food in the stomach. This is shown in Table 180 giving 1) percentage of herring containing the different groups of organisms, and 2) average number of the respective organisms per herring containing such.

Table 180. Stomach analyses of immature herring (15 fish) from Groves Flak, SE of Læsø, $^{7}/_{10}$ 1922.

	Percentage of herring containing the different organisms	Average no. of the resp. organisms per herring containing such
Cladocera	66.7 % (10 : 15)	3 spec. (34 : 10)
Copepoda	100.0 — (15 : 15)	86 — (1292 : 15)
Cirripedia	6.7 — (1 : 15)	1 — (1 : 1)
Decapoda	46.7 — (7 : 15)	33 — (234 : 7)
Amphipoda	6.7 — (1 : 15)	1 — (1 : 1)
Chætognatha	13.3 — (2 : 15)	8 — (16 : 2)

It will be seen that cladocerans, copepods and decapods appeared in the food of a considerable number of the herring examined, the average number of specimens per fish however, being particularly high in the case of the last two groups. Closer examination of the occurrence of the different organisms in the food reveals the following features:

Cladocera. *Podon* was the only genus represented in the stomach contents, appearing in 66.7 % of the herring examined, but only in comparatively small numbers (average 3 per fish).

Copepoda. The occurrence of the various copepods in the stomach contents of these fish will be seen from the following table.

Table 181. Relative importance of the different copepods as food for immature herring from Groves Flak.

	Percentage of herring containing the different copepods	Average no. of the resp. copepods per herring containing such
Calanus finmarchicus (Gunner.)	46.7 % (7 : 15)	17 spec. (122 : 7)
Pseudocalanus elongatus Boeck + *Paracalanus parvus* Claus.	86.7 — (13 : 15)	6 — (79 : 13)
Centropages typicus Krøyer	86.7 — (13 : 15)	14 — (182 : 13)
Centropages hamatus (Lillj.)	20.0 — (3 : 15)	2 — (5 : 3)
Isias clavipes Boeck	13.3 — (2 : 15)	1 — (3 : 2)
Temora longicornis (O. F. Müller)	100.0 — (15 : 15)	57 — (853 : 15)
Candacia armata (Boeck)	6.7 — (1 : 15)	1 — (1 : 1)
Labidocera Wollastoni Lubbock	6.7 — (1 : 15)	1 — (1 : 1)
Acartia sp.	6.7 — (1 : 15)	1 — (1 : 1)

The copepods *Temora*, *Pseudocalanus + Paracalanus*, *Centropages typicus* and *Calanus* were found in a great number of the herring examined. Calculating from the total of these copepods (1236) the relative number of the different species, we obtain the following: *Temora longicornis* 69.0 %, *Centropages typicus* 14.7 %, *Calanus finmarchicus* 9.9 % and *Pseudocalanus + Paracalanus* 6.4 %. From this it appears that *Temora* was by far the most important copepod in the food of the herring from these waters.

Cirripedia. A single cirripede larva in the cypris stage was found in the stomach contents.

Decapoda. Larval decapods were found in the food of 46.7 % of the herring examined, with an average of 33 per fish. Crab larvæ were by far the commonest forms, and most of these were larval stages

of *Cancer pagurus* L. In addition, a few zoea stages of *Pinnotheres pisum* (L.) were identified with certainty, as were also a number of larval stages of *Crangon*.

Amphipoda. Only a single specimen was found, and this could not be further identified.

Chætognatha. *Sagitta* appeared in the food of 13.3 % of the herring examined, with an average of 8 per fish.

It will be seen from these investigations that the mature autumn-spawning herring in this part of the Kattegat feed only to a very slight extent, whereas immature fish were found to contain considerable quantities of food.

6. The North Sea. Stations along the West Coast of Jutland.

Samples of young herring (total length 9—15 cm.) were taken at stations off the west coast of Jutland. There were three samples in all, the localities being as follows (see chart, p. 8):

St. 2836. 55° 52′ N., 8° 06′ E. Off Nyminde Gab, $^{27}/_{9}$ 1922, 10 a. m. Herring trawl, depth 15 m.
St. 2847. 56° 22′ N., 8° 05′ E. Outside Nissum Fjord, $^{30}/_{9}$ 1922, 11 a. m. Herring trawl, depth 15 m.
St. 3146. 57° 10′ N., 8° 40′ E. Off Hanstholm, $^{31}/_{12}$ 1923, 4 p. m. Young fish trawl, depth 9 m.

We will first compare the stomach analyses for the two first mentioned samples, which were taken at the same season, over the same depth and at approximately the same time (10—11 a. m.). The distance between the two stations is about 30 miles. The sample from St. 2836 comprised 20 fish, and that from St. 2847 22, with definite stomach contents. A detailed survey of the stomach analyses is given in Tables XVII and XVIII (p. 140). Table 182 below gives, for both stations, the percentage of herring containing the different organisms, and the average number of the different organisms per fish.

Table 182. Comparative table showing (I) percentages of herring containing the different organisms and (II) average numbers of the respective organisms per herring containing such. Stations 2836 and 2847.

	I. Percentages		II. Average numbers	
	St. 2836	St. 2847	St. 2836	St. 2847
Copepoda	100.0 (20 : 20)	100.0 (22 : 22)	143 (2859 : 20)	33 (723 : 22)
Mysidacea	10.0 (2 : 20)	4.5 (1 : 22)	1 (2 : 2)	1 (1 : 1)
Decapoda	100.0 (20 : 20)	4.5 (1 : 22)	39 (780 : 20)	1 (1 : 1)
Cumacea	10.0 (2 : 20)	—	1 (2 : 2)	—
Amphipoda	5.0 (1 : 20)	—	2 (2 : 1)	—
Chætognatha	70.0 (14 : 20)	63.6 (14 : 22)	17 (233 : 14)	4 (55 : 14)
Appendiculariæ	—	18.2 (4 : 22)	—	2 (9 : 4)

A glance at this table shows that the differences are quite considerable. Copepods appear in the stomach contents of all the herring examined from both stations, but the average number of copepods per fish is far greater at St. 2836 (143 spec.) than at St. 2847 (33 spec.). In several of the other groups also, we find that the average is considerably higher at St. 2836 than at St. 2847. Decapods for instance, appear in the food of all the herring from St. 2836, with an average of 39 per fish, whereas at St. 2847, only one herring contains a single specimen. The great number of decapods from the former station is composed almost exclusively of larval stages of *Crangon*. Chætognaths appear in the food of nearly as many herring at both stations, but the greatest number of specimens falls to St. 2836.

The occurrence of the various species of copepods in the stomach contents of these fish likewise shows considerable difference as between the two stations (Table 183).

Table 183. Comparative table showing (I) percentages of herring containing the different copepods, and (II) average numbers of the respective copepods per herring containing such. St. 2836 and 2847.

	I. Percentages		II. Average numbers	
	St. 2836	St. 2847	St. 2836	St. 2847
Calanus finmarchicus (Gunner.)	100.0 (20 : 20)	63.6 (14 : 22)	123 (2467 : 20)	2 (26 : 14)
Pseudocalanus elongatus Boeck + *Paracalanus parvus* Claus	10.0 (2 : 20)	59.1 (13 : 22)	1 (2 : 2)	2 (31 : 13)
Centropages typicus Krøyer	5.0 (1 : 20)	—	1 (1 : 1)	—
Centropages hamatus (Lillj.)	10.0 (2 : 20)	—	1 (3 : 2)	—
Isias clavipes Boeck	5.0 (1 : 20)	4.5 (1 : 22)	1 (1 : 1)	1 (1 : 1)
Temora longicornis (O. F. Müller)	100.0 (20 : 20)	100.0 (22 : 22)	17 (332 : 20)	30 (665 : 22)
Labidocera Wollastoni Lubbock	70.0 (14 : 20)	—	3 (38 : 14)	—
Parapontella brevicornis (Lubbock)	50.0 (10 : 20)	—	1 (14 : 10)	—
Harpacticidæ	5.0 (1 : 20)	—	1 (1 : 1)	—

It will be seen from the average figures that *Calanus finmarchicus* was greatly predominant in the stomach contents of herring from St. 2836, whereas *Temora longicornis* was most numerous at St. 2847. At the former station, two species, *Labidocera Wollastoni* and *Parapontella brevicornis* were found in a considerable number of the fish examined (70 and 50 % respectively), but were not found in the stomach contents of herring from St. 2847.

The relative importance of the different copepods as food for the herring in the two localities, calculated from the total number of copepods counted in the stomach analyses, will be seen from Table 184.

Table 184. Relative importance of the different copepods as food for the herring at St. 2836 and 2847.

	St. 2836		St. 2847	
	No.	%	No.	%
Calanus finmarchicus	2467	86.29	26	3.59
Pseudocalanus + *Paracalanus*	2	0.07	31	4.29
Centropages typicus	1	0.04	—	—
Centropages hamatus	3	0.10	—	—
Isias clavipes	1	0.04	1	0.14
Temora longicornis	332	11.61	665	91.98
Labidocera Wollastoni	38	1.33	—	—
Parapontella brevicornis	14	0.49	—	—
Harpacticidæ	1	0.03	—	—

The conspicuous difference in the relative frequency of *Calanus* and *Temora* in the food of the herring at these two stations will be more easily understood when we come to look at the composition of the plankton. *Calanus* was the commonest copepod in the plankton sample from St. 2836, whereas *Temora* was greatly predominant numerically in the sample from St. 2847.

The third sample of young herring, taken off Hanstholm, (St. 3146) on the $^{31}/_{12}$ 1923, is remarkable in that a comparatively large number of these fish had no food at all in the stomach. Out of a total of 18, only 13 had definite stomach contents, a percentage of 72.2, which is rather low for young herring. The relative numbers of fish containing the various groups of organisms were as follows: copepods 84.6 %, mysids 38.5 %, amphipods 30.8 %, euphausiids 15.4 % and cumacea 7.7 %. The average number of copepods per fish containing such was 8. The total number of identifiable copepods noted in the stomach analyses was only 68, of which 25 were *Temora longicornis* (O. F. Müller), 20 *Centropages typicus* Krøyer, 15 *Calanus finmarchicus* (Gunner.), 7 *Pseudocalanus elongatus* Boeck + *Paracalanus parvus* Claus and 1 *Corycæus anglicus* Lubbock. Other organisms particularly worthy of note were: euphausiids: two young specimens of *Meganyctiphanes norvegica* (M. Sars); mysids: *Gastrosaccus spinifer* (Goës) and *Schistomysis ornata* (G. O. Sars); amphipods: *Hyperia galba* (Mont.); and cumacea: *Lamprops fasciata* G. O. Sars.

7. The North Sea. Graadyb.

a. Material.

When the marine research vessel "Dana" was stationed at Esbjerg in winter, occasional pelagic hauls were made in the Graadyb, with young fish trawl and herring trawl, which yielded a considerable material of young herring. The collections were made practically in the same position throughout, viz. about 55° 24′ N., 8° 12′ E., the depth being 10—12 metres (see chart, p. 8).

The total material subjected to stomach analysis comprised 1806 fish, but a number of these were used for special experiments, which will be dealt with later on (pp. 128—132). The collections were made at very irregular intervals, sometimes only one haul in a month, at others several during the same length of time. We will therefore take the month as unit, and where several hauls occurred in the same month, they will be taken together as a whole.

The herring captured in the Graadyb were mainly young fish, total length 6—14 cm.; there were also however, 14 specimens of younger stages (3—4 cm.). To give an idea as to the sizes of the fish, the numbers are shown in relation to size in Table 185 comprising all the present material from Graadyb. The 3—4 cm. fish, (numbers in parentheses) are presumably young specimens of spring-spawning herring. The few specimens of 14—15 cm. from November and January 1922—23, likewise noted in parentheses,

Table 185. Length and number of herring examined from Graadyb, for the winter half-years of 1922—23, 1923—24, 1924—25 and 1925—26.

Length in cm.	1922—23				1924		1924—25			1925—26			
	Nov.	Jan.	Feb.	March	Jan.	March	Dec.	Jan.	Feb.	Oct.	Nov.	Jan.	March
3	..	..	..	..	..	..	..	(1)	..	..	..	..	.
4	..	..	..	..	(1)	(2)	..	(10)	..	..	..	..	..
5	..	..	..	..	..	..	..	..	..	..	..	..	..
6	..	..	..	..	1	..	..	..	..	..	..	..	1
7	..	5	12	41	5	1	1	..	..	..	1	1	27
8	4	79	65	118	12	10	1	4	..	38	35	29	248
9	92	95	53	39	44	49	14	14	..	36	17	13	97
10	45	23	19	6	38	38	37	23	2	4	1	3	7
11	5	7	2	1	7	5	68	35	2	2	..	1	2
12	..	2	..	..	1	2	49	10	4	..	..	1	..
13	..	..	..	..	..	..	18	10	1	..	..	1	..
14	(1)	(1)	..	..	..	..	3	2	..	..	..	..	..
15	..	(1)	..	..	..	..	..	..	..	..	..	..	..

are probably older fish, whereas all the remaining herring must presumably be 1—1½ year old specimens of autumn-spawning herring.

It will be noted that the average length for 1924—25 was considerably higher than for the previous winters. This is plainly apparent on calculating the average sizes for the separate winters, ignoring those individuals shown in parentheses in Table 185:

November 1922—March 1923	8.65 cm.	(713 spec.)
January 1924—March 1924	9.34 —	(213 —)
December 1924—February 1925	11.00 —	(298 —)
October 1925—March 1926	8.33 —	(565 —)

Plankton samples were taken simultaneously with the herring samples, save in 1922—23, when no plankton samples were taken.

b. The relative numbers of herring containing food in the different months.

As will be seen from Table 186 the young herring of Graadyb (length 6—15 cm.) feed very largely in the winter half year. This agrees exceedingly well with the corresponding values for young herring (length 42—127 mm.) from the east coast of England (HARDY 1924, pp. 12 – 13). Among the young herring from Graadyb we have an average of 92.8 % containing food, and HARDY's figure for young herring from the south-western North Sea is 89.1 %.

Table 186. Monthly percentages of herring containing food. Graadyb.

(Figures in parentheses indicate respectively no. of herring with food and no. of herring examined.)

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	97.1 (134 : 138)	x	73.1 (87 : 119)	100.0 (151 : 151)	100.0 (150 : 150)
1923—24	x	x	x	97.1 (68 : 70)	x	96.6 (84 : 87)
1924—25	x	x	94.4 (168 : 178)	96.0 (72 : 75)	88.9 (8 : 9)	x
1925—26	88.7 (71 : 80)	x	x	84.0 (42 : 50)	x	93.5 (173 : 185)

c. Brief survey of the composition of the food.

On comparing the occurrence of crustacea and non-crustacea in the food we find that crustacea appear in nearly all fish with definite stomach contents, whereas the occurrence of other organisms varies considerably in the different months. Table 187 will serve to illustrate this.

Table 187. Monthly percentages of herring containing crustaceous and non-crustaceous food. Graadyb.

	Crustaceous food						Non-crustaceous food					
	Oct.	Nov.	Dec.	Jan.	Feb.	March	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	99.3 (133 : 134)	x	100.0 (87 : 87)	100.0 (151 : 151)	100.0 (150 : 150)	x	36.6 (49 : 134)	x	2.3 (2 : 87)	21.9 (32 : 151)	4.0 (6 : 150)
1923—24	x	x	x	100.0 (68 : 68)	x	100.0 (84 : 84)	x	x	x	13.2 (9 : 68)	x	0 (0 : 84)
1924—25	x	x	98.8 (166 : 168)	100.0 (72 : 72)	100.0 (8 : 8)	x	x	x	3.6 (6 : 168)	2.8 (2 : 72)	0 (0 : 8)	x
1925—26	100.0 (71 : 71)	x	x	100.0 (42 : 42)	x	100.0 (173 : 173)	39.4 (28 : 71)	x	x	0 (0 : 42)	x	1.7 (3 : 173)

Taking the whole of the present material, 1208 specimens, we find crustaceous food in 99.8 % and non-crustaceous food in 11.3 % of the fish examined. It is worth noting that non-crustaceous food appear to be most prominent during the months of October and November.

Proceeding then to consider the percentages of herring containing the various organisms, we arrive at the result given in Table 188.

The values here given are reproduced in the accompanying graph (Fig. 7, p. 100), only the principal organisms however, being there included. Among the crustacea, for instance, isopods and cirripede larvæ have been omitted, and among non-crustacea, lamellibranch larvæ, bryozoa larvæ and fish, these being

Table 188. Monthly percentages of herring containing the various groups of organisms, calculated from the total number of feeding herring in the respective months. Graadyb.

	1922—23				1924		1924—25			1925—26		
	Nov.	Jan.	Feb.	March	Jan.	March	Dec.	Jan.	Feb.	Oct.	Jan.	March
Copepoda	99.3	95.4	96.0	100.0	98.5	100.0	91.7	97.2	100.0	100.0	100.0	99.4
Mysidacea	1.5	16.1	21.9	11.3	50.0	8.3	31.0	13.9	—	2.8	2.4	—
Amphipoda	13.4	2.3	4.6	3.3	10.3	—	13.1	9.7	12.5	5.6	2.4	0.6
Isopoda	2.3	—	—	—	—	—	0.6	—	—	—	—	—
Cirripedia	—	—	—	—	—	—	2.4	—	—	—	4.8	—
Decapoda	8.2	—	17.2	0.7	1.5	—	1.8	2.8	—	5.6	—	—
Cumacea	2.2	—	15.9	4.0	—	—	14.9	12.5	12.5	1.4	—	—
Polychæta	19.4	1.1	—	—	—	—	—	—	—	5.6	—	—
Lamellibranchiata	1.5	—	—	—	—	—	0.6	—	—	—	—	0.6
Bryozoa	—	1.1	—	—	—	—	—	—	—	—	—	—
Chætognatha	3.7	—	20.5	3.3	13.2	—	3.6	1.4	—	14.1	—	1.2
Appendicularіæ	14.9	—	—	—	—	—	1.2	—	—	31.0	—	—
Pisces	—	—	0.7	0.7	—	—	—	1.4	—	—	—	—

of altogether minimal importance as food. A glance at the graph shows that copepods appear in the food of nearly all the herring examined, none of the other organisms being found in so great a number of fish. It will be noticed that cladocerans do not appear in the food; this is owing to the fact that the investigations covered only the winter half year. Mysids appear during one month (Jan. 1924) in 50 % of the fish; such a high percentage however, is rather exceptional. They seem to serve as food more particularly in December and January. Amphipods, decapods and cumacea show on the whole lower figures, and appear in the greatest numbers from November—February. Of organisms other than crustacea, the chætognaths are noted for most of the months, while the polychætes and appendicularians have a pronounced maximum in October and November.

d. Systematic survey of the occurrence of the different organisms in the food.

In the following systematic survey of the different organisms found in the stomach contents of young herring from Graadyb, only fish between 6 and 15 cm. total length have been included. The few younger specimens examined (length 3—4 cm.) had very little food in the stomach, and the food itself did not differ to any essential degree from that of older fish caught at the same time. In the following, the crustacea are taken first. For explanation of tables see p. 11.

Copepoda.

As already mentioned, copepods appear in the food of a great number of herring from all the months covered by the investigations. The percentages for the different months range from 95.4—100 % of all herring containing food (Table 189, p. 100). We thus have always a large number of herring containing copepods; there is, however, consider-

able difference as to the numbers of copepods found in the stomachs during the different months. This will be seen from Table 190. We find, on the whole, higher figures for February and March than from October to January. Calculating the average of the monthly values, we obtain the following: October 9, November 19, December 12, January 22, February 49 and March 64 specimens per fish. It should here be noted, however, that investigations during the three first-mentioned months were only made in one year.

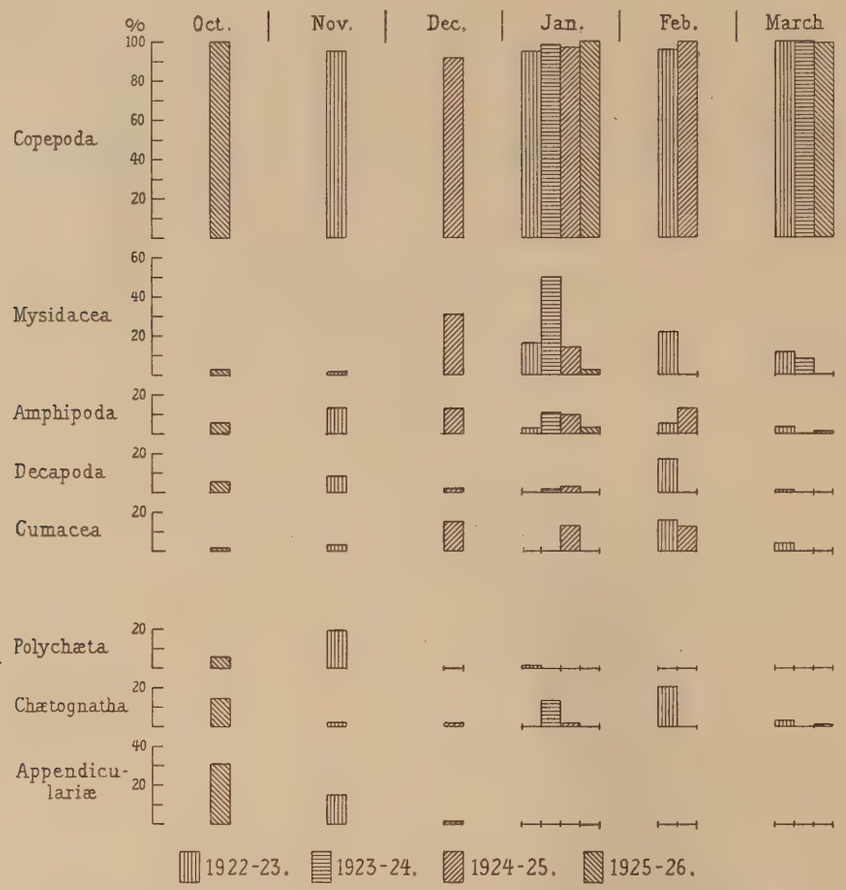


Fig. 7. Monthly percentages of herring stomachs containing the more important groups of organisms. Graadyb.

Table 189. Monthly percentages of herring containing copepods. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23.	x	99.3 (133 : 134)	x	95.4 (83 : 87)	96.0 (145 : 151)	100.0 (150 : 150)
1923—24.	x	x	x	98.5 (67 : 68)	x	100.0 (84 : 84)
1924—25.	x	x	91.7 (154 : 168)	97.2 (70 : 72)	100.0 (8 : 8)	x
1925—26.	100.0 (71 : 71)	x	x	100.0 (42 : 42)	x	99.4 (172 : 173)

Table 190. Average number of copepods per herring containing such.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23.	x	19 (2583 : 133)	x	6 (536 : 83)	60 (8763 : 145)	112 (16791 : 150)
1923—24.	x	x	x	43 (2903 : 67)	x	57 (4756 : 84)
1924—25.	x	x	12 (1884 : 154)	27 (1912 : 70)	38 (308 : 8)	x
1925—26.	9 (604 : 71)	x	x	12 (487 : 42)	x	24 (4205 : 172)

The following copepods were found in the food of the herring from Graadyb:

Calanus finmarchicus (Gunner.)
Pseudocalanus elongatus Boeck
Paracalanus parvus Claus
Centropages typicus Krøyer
Centropages hamatus (Lillj.)
Isias clavipes Boeck
Temora longicornis (O. F. Müller)
Anomalocera Patersoni Templeton
Labidocera Wollastoni Lubbock
Acartia longiremis (Lillj.)
Acartia Clausi Giesbrecht
Oithona spinirostris Claus
Oithona similis Claus
Microsetella norvegica (Boeck)
Euterpina acutifrons (Dana)
Corycæus anglicus Lubbock
Monstrilla sp.
Caligus sp.

In the stomach analyses, no distinction could be made between the two species *Pseudocalanus elongatus* and *Paracalanus parvus*, and the same applies to species of the genus *Acartia*, also to those of the genus *Oithona*. The harpacticids are taken together in the following, as, in addition to the species noted above, a number of other harpacticids were found but could not be further identified. The number of unidentifiable copepods amounted to 8—9 % of all copepods in the material.

Table 191 gives the numbers and percentages of the different copepods for each month and for the whole of the present material.

Table 191. Relative importance of the various copepods as food for the herring during the different months, and for the whole of the present material. Graadyb.

	Oct.		Nov.		Dec.		Jan.		Feb.		March		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Calanus finmarchicus	3	0.50	241	9.62	24	1.30	85	1.62	2	0.03	18	0.08	373	0.894
Pseudocalanus + Paracalanus	142	23.51	960	38.31	36	1.96	589	11.19	1264	16.63	13414	56.11	16405	39.322
Centropages typicus	—	—	75	2.99	36	1.96	603	11.46	—	—	—	—	714	1.711
Centropages hamatus	3	0.50	56	2.23	19	1.03	73	1.39	59	0.78	317	1.33	527	1.263
Isias clavipes	—	—	—	—	—	—	1	0.02	—	—	—	—	1	0.003
Temora longicornis	360	59.60	739	29.49	1719	93.32	3852	73.20	5811	76.45	9944	41.60	22425	53.751
Anomalocera Patersoni	—	—	282	11.25	—	—	—	—	—	—	—	—	282	0.676
Labidocera Wollastoni	3	0.50	15	0.60	—	—	—	—	—	—	—	—	18	0.043
Acartia sp.	1	0.17	14	0.56	—	—	51	0.97	445	5.85	65	0.27	576	1.381
Oithona sp.	2	0.33	25	1.00	—	—	—	—	5	0.07	1	< 0.01	33	0.079
Harpacticidæ	81	13.41	95	3.79	5	0.27	1	0.02	14	0.18	144	0.60	340	0.815
Corycæus anglicus	7	1.16	2	0.08	3	0.16	5	0.09	1	0.01	—	—	18	0.043
Monstrilla sp.	1	0.16	—	—	—	—	—	—	—	—	—	—	1	0.002
Caligus sp.	1	0.16	2	0.08	—	—	2	0.04	—	—	2	0.01	7	0.017

Temora longicornis is the species found in greatest numbers during most months, but more especially in Dec.—Feb. Next to *Temora*, *Pseudocalanus* + *Paracalanus* are the most important copepods. They appear in rather small numbers in Dec. and Jan., but attain very considerable frequency, especially in March. The remaining copepods are of rather slight importance as food; there is reason to note, however, that in a single month (October) harpacticids appear in relatively great numbers, and the same applies to *Calanus* and *Anomalocera* (Nov.), also *Centropages typicus* (Jan.).

On considering the percentages of herring containing the different copepods, we find that the figures for the principal copepods agree fairly well with the results above noted. *Temora*, for instance, appears in 88.0 % of all fish with definite stomach contents, and *Pseudocalanus* + *Paracalanus* in 56.4 %. The percentages are given in Table 192 both for the separate months and for the entire material.

Table 192. Percentages of herring containing the different copepods for the different months, and for the entire material of herring from Graadyb.

	1922—23				1924		1924—25			1925—26			Total
	Nov.	Jan.	Feb.	March	Jan.	March	Dec.	Jan.	Feb.	Oct.	Jan.	March	
Calanus finmarchicus	45.5	1.1	—	2.1	36.8	8.3	11.9	4.2	12.5	4.2	—	2.3	10.7
Pseudocalanus + Paracalanus	38.8	43.7	58.3	100.0	39.7	81.0	15.5	50.0	37.5	50.7	9.5	88.4	56.4
Centropages typicus	28.4	—	—	—	25.0	—	14.6	18.1	—	—	—	—	7.8
Centropages hamatus	25.4	27.6	19.2	33.3	17.6	15.5	8.9	22.2	12.5	2.8	—	5.8	17.1
Isias clavipes	—	—	—	—	1.5	—	—	—	—	—	—	—	0.1
Temora longicornis	51.5	78.2	94.7	100.0	95.6	100.0	88.7	95.8	100.0	78.9	100.0	92.5	88.0
Anomalocera Patersoni	33.6	—	—	—	—	—	—	—	—	—	—	—	3.7
Labidocera Wollastoni	9.0	—	—	—	—	—	—	—	—	2.8	—	—	1.2
Acartia sp.	1.5	—	26.5	10.7	10.3	2.4	—	5.6	—	1.4	—	4.6	6.6
Oithona sp.	6.7	—	2.0	—	—	—	—	—	—	2.8	—	0.6	1.2
Harpacticidæ	20.1	—	6.0	26.7	1.5	—	3.0	—	—	52.1	—	6.4	10.8
Corycæus anglicus	1.5	—	0.7	—	1.5	—	1.2	4.2	—	9.9	—	—	1.3
Monstrilla sp.	—	—	—	—	—	—	—	—	—	1.4	—	—	0.1
Caligus sp.	1.5	—	—	—	—	—	—	1.4	—	1.4	—	—	0.3

Calanus finmarchicus. In some months, this species is found in the food of a considerable number of the herring investigated (Table 193), but the average number per fish is always small. *Calanus* was noted in greatest numbers in November 1922, when we find it in 45.5 % of the herring examined, with an average of 4 specimens per fish (maximum 14).

Table 193. Monthly percentages of herring containing Calanus finmarchicus. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	45.5 (61 : 134)	x	1.1 (1 : 87)	—	2.1 (4 : 150)
1923—24	x	x	x	36.8 (25 : 68)	x	8.3 (7 : 84)
1924—25	x	x	11.9 (20 : 168)	4.2 (3 : 72)	12.5 (1 : 8)	x
1925—26	4.2 (3 : 71)	x	x	—	x	2.3 (4 : 173)

In the plankton samples, *Calanus* was common in November and December; small numbers were noted in the other months.

Pseudocalanus elongatus + *Paracalanus parvus.* These are, next to *Temora*, the most important copepods in the food. They appear in the stomach contents from all the samples examined, but in the greatest relative number of fish in March (Table 194). Table 195 shows that the greatest numbers are found in February and March. The greatest number noted in the stomach of a single fish is 306 (March 1923).

On considering the occurrence of the two species in the plankton samples, we find that *Pseudocalanus* was common in all the months covered by the investigations, excepting October (1925) when only small numbers were found; *Paracalanus*, on the other hand, was only recorded as common in Oct., Nov. and December. The great majority of the copepods referred to these species in the stomach analyses for February and March will thus undoubtedly be *Pseudocalanus*.

Table 194. Monthly percentages of herring containing Pseudocalanus + Paracalanus. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	38.8 (52 : 134)	x	43.7 (38 : 87)	58.3 (88 : 151)	100.0 (150 : 150)
1923—24...	x	x	x	39.7 (27 : 68)	x	81.0 (68 : 84)
1924—25...	x	x	15.5 (26 : 168)	50.0 (36 : 72)	37.5 (3 : 8)	x
1925—26...	50.7 (36 : 71)	x	x	9.5 (4 : 42)	x	88.4 (153 : 173)

Table 195. Average number of Pseudocalanus + Paracalanus per herring containing such.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	18 (960 : 52)	x	2 (89 : 38)	13 (1122 : 88)	69 (10327 : 150)
1923—24...	x	x	x	14 (381 : 27)	x	11 (727 : 68)
1924—25...	x	x	1 (36 : 26)	3 (115 : 36)	47 (142 : 3)	x
1925—26...	4 (142 : 36)	x	x	1 (4 : 4)	x	15 (2360 : 153)

Centropages typicus only appears in the stomach contents of the herring in Nov., Dec. and January. The species is noted in the following relative numbers of herring with positive stomach contents: Nov. (1922) 28.4 %, Dec. (1924) 14.6 % and in January 1924 and 1925, 25.0 % and 18.1 % respectively. The average number of specimens per herring containing such for the different months is only 1—2, except for January 1924, where the average is 35. The sample for this month contained 587 specimens distributed among 17 herring, with as many as 156 in a single fish. In the plankton samples, the species was recorded for those months in which it appeared in the stomach contents, but always in small numbers.

Centropages hamatus. In contrast to the foregoing, this species appeared in the food during all months from October to March, and in some months, it was found in the stomach contents of a considerable number of the herring examined (Table 196).

Table 196. Monthly percentages of herring containing Centropages hamatus. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	25.4 (34 : 134)	x	27.6 (24 : 87)	19.2 (29 : 151)	33.3 (50 : 150)
1923—24...	x	x	x	17.6 (12 : 68)	x	15.5 (13 : 84)
1924—25...	x	x	8.9 (15 : 168)	22.2 (16 : 72)	12.5 (1 : 8)	x
1925—26...	2.8 (2 : 71)	x	x	—	x	5.8 (10 : 173)

Table 197. Average number of Centropages hamatus per herring containing such.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	2 (56 : 34)	x	1 (34 : 24)	2 (56 : 29)	6 (290 : 50)
1923—24...	x	x	x	2 (19 : 12)	x	1 (17 : 13)
1924—25...	x	x	1 (19 : 15)	1 (20 : 16)	3 (3 : 1)	x
1925—26...	1 (3 : 2)	x	x	—	x	1 (10 : 10)

It will be seen from Table 197 that the averages are low, the high figure for the March 1923 being due to the presence of a single fish containing an altogether unusually large number (195). The species is noted in all the plankton samples, but always in comparatively small numbers.

Isias clavipes. A single specimen is found in the stomach of a herring from January (1924) but the species is not noted in the plankton samples.

Temora longicornis. This is, numerically, the most important copepod. It appears in all months covered by the investigations, and in 51.5—100 % of the herring examined (Table 198). Both the percentages and the averages for number of specimens per fish (Table 199) are on the whole higher for Jan.—March than for Oct.—Dec.

Table 198. Monthly percentages of herring containing Temora longicornis. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	51.5 (69 : 134)	x	78.2 (68 : 87)	94.7 (143 : 151)	100.0 (150 : 150)
1923—24...	x	x	x	95.6 (65 : 68)	x	100.0 (84 : 84)
1924—25...	x	x	88.7 (149 : 168)	95.8 (69 : 72)	100.0 (8 : 8)	x
1925—26...	78.9 (56 : 71)	x	x	100.0 (42 : 42)	x	92.5 (160 : 173)

Table 199. Average number of Temora longicornis per herring containing such.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	11 (739 : 69)	x	4 (256 : 68)	40 (5670 : 143)	32 (4816 : 150)
1923—24...	x	x	x	22 (1404 : 65)	x	42 (3528 : 84)
1924—25...	x	x	12 (1719 : 149)	25 (1719 : 69)	18 (141 : 8)	x
1925—26...	6 (360 : 56)	x	x	11 (473 : 42)	x	10 (1600 : 160)

The greatest number of specimens found in the stomach of a single fish is 455 (Feb. 1923). *Temora* is noted as common in all the plankton samples taken.

Anomalocera Patersoni only appeared in a single month (November 1922) but was then found in the stomach contents of 33.6 % of the herring examined. In the sample in question, 45 fish were found to contain 282 specimens (maximum 86 per fish). We have unfortunately no plankton samples for the autumn of 1922, and the species was not observed in the plankton samples of the subsequent years.

Labidocera Wollastoni was only noted in October and November. During the former month, the species was found in 2.8 % of the herring examined, and in the latter of 9.0 %, but always in small numbers. The maximum noted in a single fish was 4. It did not appear in the plankton samples.

Acartia sp. During most months, the genus *Acartia* appears in the food of a comparatively small number of herring (Table 200). An exception is formed by the sample for Feb. 1923, where we have *Acartia* in the stomach contents of 26.5 % of the fish. The average numbers per fish are rather high (Table 201) when we consider that these copepods are generally found in the stomach contents of relatively few herring. The greatest number of *Acartia* counted in the stomach content of a single fish is 32 (Feb. 1923).

Table 200. Monthly percentages of herring containing Acartia. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	1.5 (2 : 134)	x	—	26.5 (40 : 151)	10.7 (16 : 150)
1923—24	x	x	x	10.3 (7 : 68)	x	2.4 (2 : 84)
1924—25	x	x	—	5.6 (4 : 72)	—	x
1925—26	1.4 (1 : 71)	x	x	—	x	4.6 (8 : 173)

Table 201. Average number of Acartia per herring containing such.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	7 (14 : 2)	x	—	11 (445 : 40)	2 (38 : 16)
1923—24	x	x	x	3 (24 : 7)	x	1 (3 : 2)
1924—25	x	x	—	7 (27 : 4)	—	x
1925—26	1 (1 : 1)	x	x	—	x	3 (24 : 8)

A. Clausi was by far the commonest species in the plankton samples. In the winter of 1924—25 it was especially numerous in the plankton. The species *A. longiremis* was noted (single specimens) in two samples.

Oithona sp. This genus is only of the very slightest importance as food. The stomach analyses show a total of 33 specimens, and the greatest number found in a single fish is 5. *O. similis* is by far the commonest form in the plankton samples, but is rarely noted in great numbers. The species *O. spinirostris* is found in the stomach content of a herring from Oct. 1925; small numbers are observed in the plankton samples for October and November.

Harpacticidæ. The occurrence of harpacticids in the food is very irregular. The greatest number of herring containing these was found in Oct.—Nov. and for one year, in March; from Dec.—Feb. they were of but slight importance (Table 202). The average number of harpacticids per fish varied for the different months from 1 to 4.

Table 202. Monthly percentages of herring containing harpacticids. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	20.1 (27 : 134)	x	—	6.0 (9 : 151)	26.7 (40 : 150)
1923—24	x	x	x	1.5 (1 : 68)	x	—
1924—25	x	x	3.0 (5 : 168)	—	—	x
1925—26	52.1 (37 : 71)	x	x	—	x	6.4 (11 : 173)

Most of the harpacticids found in the food belong to the species *Microsetella norvegica* and *Euterpina acutifrons*. Young specimens of various other harpacticids were also found, but the species could not be determined with certainty. *Microsetella norvegica* was noted, singly, in plankton samples from October to January; a few specimens of *Euterpina acutifrons* in samples from October and March.

Corycæus anglicus. Only small numbers were found in the food. October had the greatest number (9.9 % of the herring examined). The species occurred in the plankton samples for Oct., Nov. and December, when it was fairly common; small numbers were also present in January (1925).

Monstrilla sp. A specimen of this genus was noted in the stomach of a herring from Oct. 1925.

Caligus sp. Only 7 specimens were found, in 4 herring from three different months (Oct., Nov. and Jan.).

Cirripedia.

Only a single nauplius was found in the herring food (Jan. 1926). The cypris stages amounted to 7 in all, in fish from Dec. and January.

Mysidacea.

The occurrence of mysids in the food is rather irregular (Table 203). The highest percentages in the present material fall to the months of Dec.—Feb., and the highest monthly average per fish is 5 (Jan. 1925). The greatest number of specimens found in the stomach of a single fish is 22. The total material of mysids found in the stomach analyses amounts to 492 specimens, only 410 of which could be determined as to species.

Table 203. Monthly percentages of herring containing mysids. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	1.5 (2 : 134)	x	16.1 (14 : 87)	21.9 (33 : 151)	11.8 (17 : 150)
1923—24	x	x	x	50.0 (34 : 68)	x	8.3 (7 : 84)
1924—25	x	x	31.0 (52 : 168)	13.9 (10 : 72)	—	x
1925—26	2.8 (2 : 71)	x	x	2.4 (1 : 42)	x	—

The numbers and percentages of the various species were as follows:

Schistomysis spiritus Norm.	258 spec.	62.9 %
Schistomysis ornata (G. O. Sars)	76 —	18.5 —
Macromysis flexuosa (O. F. Müller)	52 —	12.7 —
Macropsis Slabberi (v. Bened.)	16 —	3.9 —
Gastrosaccus spinifer (Goës)	7 —	1.7 —
Macromysis inermis (Rathke)	1 —	0.3 —

Gastrosaccus spinifer. Single specimens were found in the stomachs of herring from Jan. 1923 and Jan. 1925.

Macropsis Slabberi. This species was found in the food during most months, but never more than 1—2 specimens per fish.

Macromysis inermis. Only a single specimen noted (Feb. 1923).

Macromysis flexuosa. This species only appeared in the food from Dec.—Feb., but fairly considerable numbers were found in some of the fish (maximum 9). The average number per fish containing this species was 2.

Schistomysis spiritus. This was by far the commonest of the mysids. It appeared in the food in all the winter months, but the greatest numbers per fish fell to Dec., Jan. and February. Taking the percentages of herring containing this species monthly, without regard to the year, we obtain the following figures:

October	November	December	January	February	March
1.4 %	0.7 %	8.3 %	11.9 %	14.5 %	1.2 %
(1 : 71)	(1 : 134)	(14 : 168)	(32 : 269)	(23 : 159)	(5 : 407)

The average number of specimens per herring containing this species was 4 (maximum 22).

Schistomysis ornata was, next to the foregoing, the commonest mysid in the food of the herring from these waters. It was found in the analyses from Dec., Jan. and Feb., with an average of 2 specimens per fish (maximum 10).

Decapoda.

In one month (Feb. 1923) decapod larvæ were found in the food of 17.2 % of the herring examined (Table 204); otherwise, they appeared in only a small number of the fish. The average for the month already mentioned was 5 specimens per fish, whereas in the remaining months it was 1—2.

The following decapod larvæ were noted in the stomach contents of the herring:

Macrura. Larval stages were found especially in Oct.—Jan., always in small numbers (maximum 2 per fish). The great majority at any rate were *Crangon* larvæ.

Brachyura. Crab larvæ were only found in Nov. 1922 and Feb. 1923. During the former month they appeared in the food of 1.5 % of the herring examined, but in February the percentage was 17.2. Crab larvæ were thus only

Table 204. Monthly percentages of herring containing decapod larvæ. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	8.2 (11 : 134)	x	—	17.2 (26 : 151)	0.7 (1 : 150)
1923—24	x	x	x	1.5 (1 : 68)	x	—
1924—25	x	x	1.8 (3 : 168)	2.8 (2 : 72)	—	x
1925—26	5.6 (4 : 71)	x	x	—	x	—

found in the food during the winter of 1922—23. In Feb. 1923, 123 crab larvæ were counted in the stomachs of 26 herring, with as many as 14 in a single fish. As far as it was possible to determine, the crab larvæ represented different stages of *Cancer pagurus* L.

Cumacea.

Cumacea were never found in any great number of the herring examined. The highest monthly percentage was 15.9 % (Table 205). In Nov. 1922, the average per fish was 5, and in Dec. 1924 it was 2, but in all the remaining months the average was only 1 per fish. The total number of cumacea found was 110, only 85 of which could be referred to their particular species or genus.

Table 205. Monthly percentages of herring containing cumacea. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	2.2 (3 : 134)	x	—	15.9 (24 : 151)	4.0 (6 : 150)
1923—24	x	x	x	—	x	—
1924—25	x	x	14.9 (25 : 168)	12.5 (9 : 72)	12.5 (1 : 8)	x
1925—26	1.4 (1 : 71)	x	x	—	x	—

Lamprops fasciata G. O. Sars was one of the commonest species, amounting to 57.6 % of all cumacea whose species or genus could be ascertained. It appeared in most of the months in which cumacea were recorded in the food.

Hemilamprops rosea (Norman). A couple of specimens were found.

Diastylis sp. Two specimens were found, one in each of two fish.

Pseudocuma sp. This genus contributed 27.1 % of all cumaceans. The only species identified with certainty was *P. longicorne* (Sp. Bate).

Campylaspis sp. Small numbers were found in the food. Such specimens as could be further identified belonged to *C. rubicunda* (Lillj.).

Isopoda.

Only 4 isopods were found in the stomach analyses, two belonging to *Eurydice pulchra* Leach, the other two being isopod larvæ at the stage commonly known as "*Microniscus*".

Amphipoda.

Amphipods appeared in the food of the herring in most of the months covered by the investigations, but never in more than 13.4 % of the herring examined (Table 206). In Jan. 1924, the average number per fish was 4 (maximum 12), for the remaining months 1—2.

The present material comprised 125 amphipods, only about half of which could be identified.

Hyperia galba (Mont.). Six specimens were found in 4 herring from a single sample (Nov. 1922).

Themisto abyssorum (Boeck). This species was likewise only found in the sample from Nov. 1922, single specimens being noted in three of the fish.

Bathyporeia sp. Amphipods of this genus appeared not infrequently in the food. *B. pelagica* (Sp. Bate) seemed to be the commonest species, but specimens of *B. Robertsoni* Sp. Bate were also found.

Apherusa sp. One badly preserved specimen was the sole representative of this genus.

Table 206. Monthly percentages of herring containing amphipods. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23	x	13.4 (18 : 134)	x	2.3 (2 : 87)	4.6 (7 : 151)	3.3 (5 : 150)
1923—24	x	x	x	10.3 (7 : 68)	x	—
1924—25	x	x	13.1 (22 : 168)	9.7 (7 : 72)	12.5 (1 : 8)	x
1925—26	5.6 (4 : 71)	x	x	2.4 (1 : 42)	x	0.6 (1 : 173)

Nototropis sp. Specimens of this genus were found in the stomachs of a number of herring; it was doubtless one of the most important genera of amphipods in the food. The species *N. Swammerdami* (M.-Edw.) was identified with certainty; there was also a specimen presumably belonging to the species *N. falcatus* (Metzg.).

Ischyrocerus sp. was found repeatedly in the stomach contents, but only single specimens. *I. anguipes* Krøyer was the only species noted.

Caprella sp. Three specimens were found, probably all *C. linearis* (L.), in the sample from Nov. 1922.

Polychæta.

The only months in which polychætes were numerous in the food were October and November. During the remaining months, only a single specimen was found, in Jan. 1923. In Oct. 1925 polychætes appeared in 5.6 % of the herring examined, and in Nov. 1923 in 19.4 %. In the former month, 6 specimens were found in 4 fish, and in the latter 33 in 26, showing that these organisms were only found in small numbers in the food. The great majority were larval stages and young polychætes which could not be further identified *inter alia* owing to their being in nearly every case badly preserved. The only species identified with certainty was *Tomopteris helgolandica* Greeff, single specimens of which were found in two herring from Nov. 1922.

Lamellibranchiata.

Lamellibranch larvæ were found in four fish (single specimens only); in the plankton samples also they were very scarce.

Bryozoa.

Among the herring of 6—15 cm. total length only a single larval stage of bryozoa — *Cyphonautes* — was found (Jan. 1923). A fish of 4 cm. length however, from March 1924, contained 9 specimens. *Cyphonautes* was often common in the plankton samples, great numbers being noted, especially in February and March. This shows that the herring only exceptionally feed on *Cyphonautes*, though it may be common in the plankton.

Chætognatha.

Sagitta was of considerable importance in the food of the herring during the winter half year. True, it was not found in any great number of the fish examined (Table 207) but the average number per fish was in some months quite considerable (Table 208). The high average (48) for January 1924 shows that these organisms were sometimes consumed in considerable numbers. *Sagitta* was found this month in the stomach contents of 9 herring, the numbers varying from 15 to 73 specimens per fish.

In all the plankton samples taken, *Sagitta* was noted as common; its occurrence in the food of the herring however was, as seen from the foregoing, highly irregular.

Table 207. Monthly percentages of herring containing Sagitta. Graadyb.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	3.7 (5 : 134)	x	—	20.5 (31 : 151)	3.3 (5 : 150)
1923—24...	x	x	x	13.2 (9 : 68)	x	—
1924—25...	x	x	3.6 (6 : 168)	1.4 (1 : 72)	—	x
1925—26...	14.1 (10 : 71)	x	x	—	x	1.2 (2 : 173)

Table 208. Average number of Sagitta per herring containing such.

	Oct.	Nov.	Dec.	Jan.	Feb.	March
1922—23...	x	1 (6 : 5)	x	—	14 (428 : 31)	2 (8 : 5)
1923—24...	x	x	x	48 (429 : 9)	x	—
1924—25...	x	x	1 (7 : 6)	1 (1 : 1)	—	x
1925—26...	2 (25 : 10)	x	x	—	x	1 (3 : 2)

Appendiculariæ.

Among the appendicularians, the genus *Oikopleura* was found in the food in the months of Oct., Nov. and December. The percentages for these months were 31.0, 14.9 and 1.2 respectively, showing that the importance of the genus decreased during the period in question. No great numbers were ever found in the individual fish (maximum 10). As in the herring samples, so also in the plankton samples, *Oikopleura* was only noted as common in Oct., Nov. and December; a few specimens were observed one year in January. The only species identified in the plankton samples was *Oikopleura dioica* Fol.

Pisces.

The stomach analyses revealed only 3 fish larvæ in all, these being 1 *Gobius sp.* Feb. 1923, 1 *Ammodytes sp.* March 1923, and an unidentifiable fish larva Jan. 1925, showing that fish larvæ were of but minimal importance as food for the herring during the winter months. No fish eggs were found in the stomach contents.

Vegetable Food.

Scanty remains of plants were found in the stomachs of a very few fish. A few diatoms were also found, but these had hardly been taken directly as food. An exception is noted in the case of a single herring from $^{22}/_{3}$ 24, which was found to contain about 120 specimens of *Coscinodiscus*.

e. Concluding remarks on the food of the herring from Graadyb.

The investigations as to food of the Graadyb herring apply only to young fish and are based exclusively on material from the winter half year (October—March). Throughout the whole of the winter, food is noted in a very great number of the fish; the percentage containing food varies for the different months from 73.1 to 100. Crustacea appear in the food of 99.8 % and non-crustacea in 11.3 % of the herring examined, showing that the crustaceans are of far greater importance than other organisms. The principal crustaceans again are the copepods, mysids and amphipods, whereas decapod larvæ, cumacea, isopods and cirripede larvæ are of subordinate importance. Among the non-crustacea should be noted particularly chætognaths, polychætes and appendicularians; small quantities of lamellibranch larvæ, bryozoa larvæ and fish are however, also observed in the food. Finally, mention must be made of a single herring which contained a considerable number of diatoms.

Copepods appear in the stomach contents of nearly all the herring examined, but seem on the whole to be more numerous in Jan.—March than in Oct.—Dec. *Temora longicornis* contributes 53.7 %, and the two species *Pseudocalanus elongatus* + *Paracalanus parvus* together 39.3 % of the total number of copepods. The percentage of other copepods found in the stomach analyses is thus very small. A comparatively large number of herring are found to contain mysids, especially in Dec.—Feb.; these organisms are however, rarely found in any great numbers in the individual fish. The commonest species is *Schistomysis spiritus*. Amphipods are found fairly frequently in the food, and the genera *Bathyporeia* and *Nototropis* are numerously represented. Of decapods, we find both macruran and brachyuran larvæ, the occurrence of these however, is very irregular. This last applies also to the cumacea, represented especially by the species *Lamprops fasciata* and the genus *Pseudocuma*. Isopods and cirripede larvæ appear only in very small numbers.

Among the non-crustacea, chætognaths (*Sagitta*) are the organisms found in greatest numbers. Considerable quantities are sometimes found in the food in January and February. Polychætes and appendicularians (*Oikopleura*) are found in the food of a considerable number of herring, but almost exclusively in October and November. Lamellibranch larvæ, bryozoa larvæ (*Cyphonautes*) and fishes do occur in the food of the herring from these waters, but it is rather exceptional to find them.

IV. Various Observations on the Food Biology of the Herring in Danish Waters.

In this chapter we shall endeavour, from the results noted in the foregoing, to form some more general conclusions as to the food of the herring in Danish waters. The various questions will be dealt with under five heads, as follows:

1. Number of herring containing food in relation to age.
2. Feeding in relation to development of genital organs.
3. Food of the adult herring in different waters and at different seasons.
4. Food of young herring compared with that of adults.
5. Investigations as to feeding at different times of the day and night.

Section 3 gives a survey of the food of adult herring in different waters and at different seasons. As young herring were only examined in any great number from Graadyb, and only from the winter half-year, the food of these has not been subjected to more general discussion. As regards the food of larval and post-larval stages, as well as that of the metamorphosis stages, reference may be made to the special section dealing with these in the previous chapter (pp. 11—18); this material was dealt with as a whole, without distinction as to the different waters from which it was derived.

There might also be reason to compare the occurrence of the various organisms in the food of the herring with their occurrence in the plankton samples, but as the plankton investigations made in this connection were not suitable for quantitative analysis, and a considerable number of the organisms serving as food for the herring were only taken to a very slight extent in the plankton hauls made, this question has not been subjected to more general consideration here. We may generally say that in the case of some organisms, as for instance copepods, cladocerans, and gastropod larvæ, a fairly good agreement is shown as between their occurrence in the food of the herring and in the plankton samples; further data as to this will be found under the heading of the respective organisms in the previous chapter.

1. Number of herring containing food in relation to age.

The material may be divided into five age groups, as follows:

1. Larval stages (yolk sac still present). Length 4—9 mm.
2. Post-larval stages (yolk sac resorbed). Length 5—ca. 36 mm.
3. Metamorphosis stages (scale formation commenced). Length ca. 38—50 mm.
4. Young herring. Length 6—ca. 17 cm.
5. Adult herring. Length ca. 17—30 cm.

The investigations show that the juvenile stages sometimes take solid food even before the yolk sac has been resorbed. This seems to be the case especially with the largest specimens (length 8—9 mm.). The number of herring larvæ found with food in the digestive tract is however, comparatively small, and the phenomenon cannot be regarded as one of very common occurrence. In the youngest post-larval stages, food is only found in a comparatively small number of specimens, but by the time they attain a size of ca. 20 mm., food is generally found in ca. 50 %, and the percentage containing food appears

thenceforward to increase fairly regularly with the growth. On entering the metamorphosis stage (ca. 38—40 mm.) food is generally found in all the specimens examined.

Proceeding then to consider the young herring we find that as a rule, a large number of these have food in the stomach. This will be seen from Table 209, which shows the monthly percentages of young herring with definite stomach contents, from Rudkøbing, Samsø, Frederikshavn, Læsø Rende and the North Sea (Graadyb, and some few samples taken at various places along the west coast of Jutland).

Table 209. Monthly percentages of young herring (6—ca. 17 cm. total length) containing food. Various localities.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rudkøbing	100.0	x	x	x	x	91.7	x	x	100.0	x	x	x
Samsø	x	x	x	x	91.7	x	x	x	x	x	x	x
Frederikshavn	x	x	x	x	x	x	x	x	x	95.7	x	x
Læsø Rende	x	x	x	x	x	x	x	100.0	x	x	x	x
North Sea	87.5	94.4	96.7	x	x	x	x	x	91.3	88.7	97.1	94.4

It will be noted that the percentages of young herring containing food are quite considerable throughout, and with comparatively little variation as between the different localities and the different months covered by the investigations. The range of variation is 87.5—100 %, and the mean values for Belt Sea (Rudkøbing and Samsø) 95.8 %, Kattegat (Frederikshavn and Læsø Rende) 97.8 % and North Sea 92.9 %.

The adult herring show a great difference in the feeding as compared with the young fish, the percentage of adults containing food being as a rule far lower, and varying to a very great extent according to month and locality. The development of the genital organs affects the feeding in some degree, but as this feature will be dealt with separately in a later section, it will be disregarded in our present consideration of the adult material. Table 210 shows the monthly percentages of adult herring containing food, for the four localities: Rudkøbing, The Sound, Samsø and Frederikshavn.

Table 210. Monthly percentages of adult herring (ca. 17—30 cm. total length) containing food. Material from four different localities inside the Skaw.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rudkøbing	24.2	68.5	23.3	60.3	72.9	67.5	39.6	71.2	34.5	26.5	49.7	71.4
The Sound	81.8	x	80.8	47.4	x	94.1	100.0	50.8	59.7	45.6	70.6	x
Samsø	x	x	x	94.2	79.5	75.0	x	x	55.3	57.1	33.7	x
Frederikshavn	x	x	x	x	x	x	70.0	42.9	39.5	58.9	0	x

It will be seen from the table that there is no marked variation in the percentages for the different months, the fluctuations in the relative numbers being very irregular. This applies to the material from Rudkøbing, which is the most complete, as well as to that from the other localities. On calculating the mean values for the different localities from the material for the months covered by the investigations, we obtain the following: Rudkøbing 50.8 %, The Sound 70.1 %, Samsø 65.8 % and Frederikshavn 42.3 %.

The result of these investigations may be summed up as follows: Herring larvæ (yolk sac still present) probably take solid food only as an exception. Post-larvæ of the smallest sizes (under 10 mm.) show only a small percentage containing food, but the number increases with increasing size, and when the metamorphosis stage is reached, food is nearly always present. The percentage of young herring with food is always very con-

siderable (average 95.5 %) compared with what we find among the adults, these showing on the average only a little over half their number with food in the stomach (57.2 %).

It is interesting in this connection to compare the above results with those arrived at by HARDY (1924) on the feeding of herring at different stages of development, from the western North Sea. His larval herring (yolk sac still present) showed food especially in the largest sizes (*l. c.*, p. 5) which agrees with our results. Post-larval stages (7—42 mm.) showed only a slight increase in the percentage of specimens with food as the length increased, but there can hardly be any doubt that HARDY's metamorphosis stages would also show a high percentage with food. He grouped these however, together with the young herring, under the heading of "Whitebait Herring" (length 42—127 mm.) showing an average percentage for all of 89.1 %.

The general features then, for post-larval stages and young herring are much the same; there is a great difference however, between the percentages of adult herring with food from the western North Sea and those from the inner Danish waters. When dealing with the material from Rudkøbing, comparison was made between the monthly percentages of herring with food from Rudkøbing, and those from the western North Sea (see Table 11, p. 20). It was then apparent that the percentage for all months of the year was considerably higher for the Rudkøbing herring than for those from the North Sea. The average percentage for the whole of the Rudkøbing material was 50.8 %, whereas HARDY (*l. c.*, p. 12) gave the mean value for March—December as 24.1 %. The low percentage for herring from the western North Sea was here due to the fact that in October, November and December, very few herring with definite stomach contents were taken, which is altogether unlike what we found in the case of the Rudkøbing fish. In the inner Danish waters, there was no particular season of the year at which the adult herring fed more than at others; in the southwestern North Sea on the other hand, there was a special season (April—August) when the number of feeding herring was at its maximum (HARDY, p. 15). Something similar has been noted in the case of the herring from the west coast of Scotland (BROOK & CALDERWOOD 1886, p. 103); the herring of the east coast of Scotland on the other hand fed more especially in winter and spring.

There can thus be little doubt that adult herring feed very differently in the different waters, the feeding being probably dependent on particular conditions of life (spawning seasons, etc.) among the different races of herring. The fact that the herring in the present material had no special season for feeding is possibly a biological peculiarity of the herring in question. It should however, be borne in mind that the catches of herring in Danish waters often consist of various races of herring, so that any biological differences existing might easily have been effaced owing to the heterogeneous composition of the catch.

2. Feeding in relation to development of genital organs.

As the present investigations concerning the degree of maturity in the herring were almost exclusively based on preserved material, the degree of maturity could only be approximately determined. It was therefore impossible to apply the system generally used for fresh material (HEINCKE 1898, Tabellen und Tafeln p. VII and JOHANSEN 1924, p. 4), but to give an idea as to the development of the genital organs, their maximal breadth was measured from the preserved material, as previously noted (p. 9). The weakest point in this method of investigation is that it was not possible to distinguish with certainty between recovering spents and maturing fish, as these stages may often be confused in the preserved material. All that we can do then is to consider the feeding of herring with slightly developed genital organs and during the growth of the same, until spawning sets in. The development of the genital organs in male and female was found to be very much the same, and the measurements for the two sexes have therefore been taken together.

To illustrate the question as to whether the degree of maturity has any effect on the feeding, we will take the adult herring from Rudkøbing and Samsø, as the material from the other localities contained

but few mature fish. There is an exception however, in the case of the samples from Groves Flak, and this material will therefore also be separately dealt with.

Table 211 shows the percentages of herring containing food in relation to the development of the genital organs, for Rudkøbing and Samsø in spring (March—June) and autumn (Sept.—Nov.). The breadth of the genital organs is given in mm., and tabulated in different size groups.

Table 211. Percentages of herring containing food in relation to development of genital organs.

	Spring		Autumn	
	Rudkøbing	Samsø	Rudkøbing	Samsø
	%	%	%	%
1— 4 mm	48.3	66.7	48.1	35.6
5— 9 —	70.7	75.9	50.0	61.1
10—14 —	50.0	95.8	38.1	48.2
15—19 —	64.1	88.0	22.8	48.3
> 20 —	62.0	73.1	20.6	43.1

These figures show that the greatest number of herring containing food is usually found among fish with genitals of a maximal breadth 5—19 mm., the percentages being often smaller in the case of full and spawning herring (maximal breadth over 20 mm.). It is also apparent that there are on the whole considerably more feeding herring at Samsø than at Rudkøbing, but in both cases we find the percentage with food is considerably higher in spring than in autumn. This difference in feeding between spring and autumn is very pronounced. Confining ourselves to the feeding of full herring (maximal breadth over 20 mm.) we find among these the following percentages with food in spring and autumn respectively: Rudkøbing 62.0 and 20.6 %, Samsø 73.1 and 43.1 %. It appears from this that full herring from Rudkøbing and Samsø feed fairly often, but to a far greater extent in spring than in autumn.

The quantity of food is undoubtedly somewhat less in the case of full herring than in those with less developed genitals, but quite considerable numbers of organisms may at times be found in the stomachs of mature herring. One spawning fish, for instance, was found to contain about 600 copepods, another 190 herring eggs and 25 copepods, a third 280 herring larvæ and a few copepods, etc.

As already mentioned, a sample of autumn-spawning herring from the eastern Kattegat, taken at Groves Flak ($^{7}/_{10}$ 1922) was also examined. As this material was examined in a fresh state, the degree of maturity was determined in accordance with the usual scale (stages I—VIII, cf. JOHANSEN 1924, p. 4). Out of 65 specimens, 39 were full herring and spawning herring (stages V—VI) and 26 spents (stage VII). Of the 39 above mentioned, only two (5.1 %) had food in the stomach, and these only very little (1 and 3 copepods). Judging from this single sample it seems that the mature autumn-spawning herring of the eastern Kattegat feed only to a very slight extent during the spawning season. Of the 26 spent fish, 5 had food in the stomach (19.2 %) but only very little (1—8 copepods). The relatively higher percentage for spent fish seems to suggest that the herring begin to feed very shortly after spawning is over, but the present investigations are not sufficiently extensive to warrant any decisive conclusions in this respect.

We can thus say that spring- and autumn-spawning herring at Rudkøbing and Samsø feed pretty generally during the spawning season, but the mature autumn-spawning herring of the eastern Kattegat seem to do so only to a very slight extent.

On consulting extant literature on the question as to whether degree of maturity in the herring affects the feeding, we find considerable difference of opinion; on the whole, however, it is generally stated that feeding is considerably reduced during the spawning season.

The great majority of writers maintain that mature herring do not feed, or at any rate only to a very slight extent. The following authorities may be quoted as holding this view: VON WRIGHT (1843, p. 132),

Boeck (1871, p. 35), Ljungman (1879, p. 270), Huxley (1881, p. 607), Trybom (1882 a, p. 288), Mc Intosh & Masterman (1897, p. 421), Heincke (1898, p. 48), Nordgaard (1907, p. 15) and Hardy (1924, p. 15). The last-named does not, it is true, deal specially with this question, but the small percentage of feeding herring in autumn and winter coincides at any rate in the main with the spawning season of the herring in the North Sea.

On the other hand, several writers state that considerable amounts of food may be found in the stomachs of herring with highly developed genital organs, and in those of spawning fish. Heincke (1878, p. 73) for instance writes of the winter herring from Kiel: "Bei den meisten untersuchten Heringen mit stark entwickelten Geschlechtsproducten, auch bei fast völlig reifen Thieren waren Magen und Darm mit Nahrung gefüllt". Sim (1883, p. 37) and Williamson (1910, p. 66) have also found food in large quantities in herring with highly developed genital organs, and Lebour (1924 b, p. 404) writes of the herring from the English Channel near Plymouth: "Running females sometimes were full of food, one with newly hatched Herring, Herring eggs and Sagitta, two full of *Nyctiphanes Couchii*, two containing many *Temora longicornis*. One spent female was full of Herring eggs, one full of *Nyctiphanes Couchii*. One mature male contained Herring eggs".

It is thus beyond doubt that full and spawning fish sometimes feed on a fairly extensive scale, but it is impossible to determine, from the present investigations, whether there may possibly be some biological difference between the different races of herring in this respect, or whether it is due rather to accidental circumstances that food is sometimes found in large quantities in the stomachs of herring with highly developed genital organs.

3. Food of the adult herring in different waters and at different seasons.

In this section, we shall endeavour to compare the results of our investigations on the food of adult herring at different localities in our waters, pointing out the differences which can be shown to exist in the composition of the food at the different seasons. Here however, difficulties arise owing to the lack of uniformity in the investigations at the different places. This is due primarily to the fact that fishing is not carried on everywhere at the same season, but other circumstances have also contributed to render the collections of material less regular than could have been desired. In order to simplify matters as far as possible, we will take the monthly calculations for the different localities, giving the percentages of fish containing the various organisms, and the mean value of the monthly results in the different years will then be considered as indicating the average for the respective months.

Before proceeding to a more detailed examination of the food, we will compare the percentages of herring containing crustaceous and non-crustaceous food for the four localities covered by the investigations of stomach contents of adult fish, viz. Rudkøbing, The Sound[1]), Samsø and Frederikshavn. Table 212 (p. 114) shows the monthly percentages of herring with crustaceous and non-crustaceous food for the localities mentioned, the values being reproduced graphically in the accompanying Figure 8.

It is at once evident that the percentage of herring containing crustacea is everywhere considerably above that of herring with non-crustacea. The range of variation for herring with crustacea is 76.1—100 % whereas for herring with non-crustacea it is 1.8—66.7 %. The mean values for the months covered by the investigations in the 4 localities are as follows:

Rudkøbing	Crustacea	93.1 %	Non-Crustacea	25.2 %
The Sound	—	94.7 —	—	30.5 —
Samsø	—	93.5 —	—	33.0 —
Frederikshavn	—	90.6 —	—	39.5 —

[1]) In the following, by "The Sound" is always understood The Sound and Køge Bugt.

Table 212. Mean monthly percentage of herring containing crustaceous and non-crustaceous food from different localities.

(Calculated from total number of herring containing food in the respective months.)

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Crustaceous food	Rudkøbing	100.0	97.3	85.7	82.7	93.9	93.7	92.6	85.7	95.2	91.7	98.3	100.0
	The Sound	100.0	x	95.2	77.8	x	100.0	100.0	100.0	89.1	94.7	95.8	x
	Samsø	x	x	x	100.0	94.0	100.0	x	x	76.1	91.1	100.0	x
	Frederikshavn	x	x	x	x	x	x	90.5	77.8	98.4	95.8	x	x
Non-crustaceous food	Rudkøbing	37.5	8.1	28.6	28.4	28.3	42.7	16.6	48.8	25.2	25.7	10.5	1.9
	The Sound	5.6	x	47.6	55.6	x	50.0	35.0	17.5	23.6	15.7	23.8	x
	Samsø	x	x	x	12.1	32.0	20.0	x	x	64.2	49.6	20.0	x
	Frederikshavn	x	x	x	x	x	x	38.1	66.7	7.8	45.4	x	x

The curves in Fig. 8 show that the non-crustacea apparently serve as food more particularly during the warmer season; the curves for the different localities are however, so dissimilar that we can hardly say anything from these as to the position as a whole.

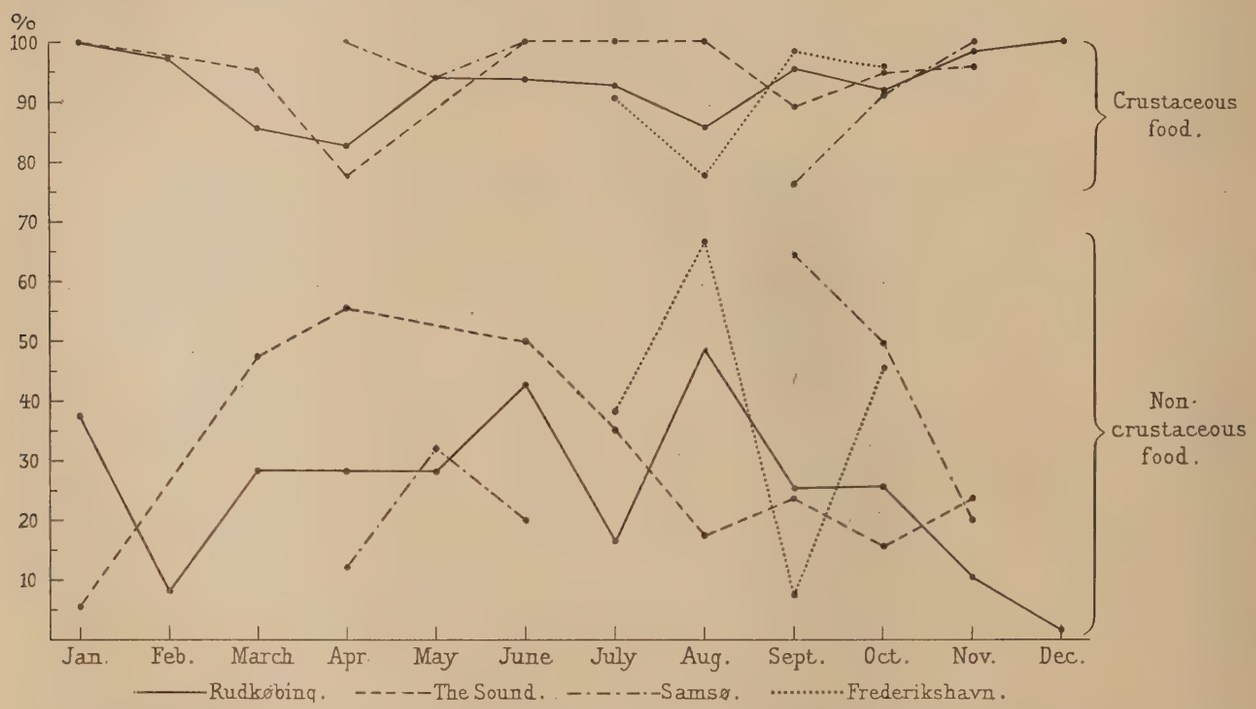


Fig. 8. Mean monthly percentage of herring containing crustaceous and non-crustaceous food from different localities.

Having no actual knowledge of the value of the different organisms as nourishment for the herring, our attention will be confined to the percentage of herring (with definite stomach contents) in which the respective organisms are found, which gives some idea of the relative importance of the organisms in question.

Table 213 shows, for the 4 localities, the average percentage of herring containing the different groups of organisms, calculated as mean values from the monthly percentages. In comparing the figures for the different localities it should be borne in mind that in one case only (Rudkøbing) have we material

from all months of the year, and that the percentages for the remaining localities are calculated on the basis of material from such months as are covered by the investigations.

Table 213. Mean percentage of herring containing different groups of organisms for the different localities.

(Calculated as means of the monthly percentages.)

	Rudkøbing	The Sound	Samsø	Frederikshavn
Copepoda	62.4	80.9	84.3	70.1
Cladocera	14.6	23.9	23.7	9.0
Mysidacea	18.5	6.3	9.1	1.2
Amphipoda	16.2	6.9	8.0	14.8
Isopoda	12.0	6.8	1.9	5.3
Cirripedia	4.6	1.4	4.1	3.8
Decapoda	4.1	4.6	2.2	33.8
Cumacea	3.0	1.2	0.1	0.3
Ostracoda	—	1.9	—	—
Polychæta	5.4	—	3.3	8.1
Gastropoda	1.3	2.7	7.2	14.8
Lamellibranchiata	—	1.2	0.1	—
Bryozoa	—	—	0.1	—
Chætognatha	0.6	3.5	1.3	7.2
Appendiculariæ	0.5	1.2	6.1	7.4
Pisces	5.3	3.3	3.0	6.5
Pisces ova	12.6	21.7	17.6	0.3

Further to illustrate the importance of the different organisms as food for the herring in the different localities, the values arrived at have been shown graphically in Fig. 9 (p. 116). Ostracods, lamellibranch larvæ and bryozoa larvæ, being of altogether subordinate importance as herring food, have been omitted from the graph.

The table above shows that copepods are found in the great majority of herring at the four localities (62—84 %). Cladocerans are found in a relatively far smaller number of fish (9—24 %). Mysids are unquestionably of great importance at Rudkøbing, and the same applies to a less pronounced degree with amphipods and isopods. At Frederikshavn also the amphipods are relatively important as herring food, and at this locality, decapod larvæ attain a very prominent position, coming next after copepods as regards the number of herring in which they are found. Cirripede larvæ and cumacea are of but slight importance throughout. Polychætes appear in 3—8 % of the herring from Rudkøbing, Samsø and Frederikshavn, but are not found at all in the herring from the Sound. Gastropods, chætognaths, appendicularians and fish have their highest relative values among the herring from Frederikshavn; fish eggs, found in the food of a fairly considerable number of herring from Rudkøbing, the Sound, and Samsø, appear in the stomach contents of only a very few fish from Frederikshavn.

Despite the fact that the investigations do not cover all months of the year at the different localities, there is reason to assume that the available data are more or less representative save in the case of Frederikshavn, where the material is only from July—October.

The main conclusions to be drawn from the present investigations may be summarised as follows: The food of the herring varies somewhat in composition at different localities in the Danish waters, but copepods are quantitatively far the most important food organisms. The organisms next in order of importance differ somewhat for the different localities: at Rudkøbing for instance, mysids come next; in the Sound and Samsø waters cladocerans; and at Frederikshavn larval decapods. Third in order of precedence are amphipods at Rudkøbing and Frederikshavn, fish eggs in the Sound and at Samsø.

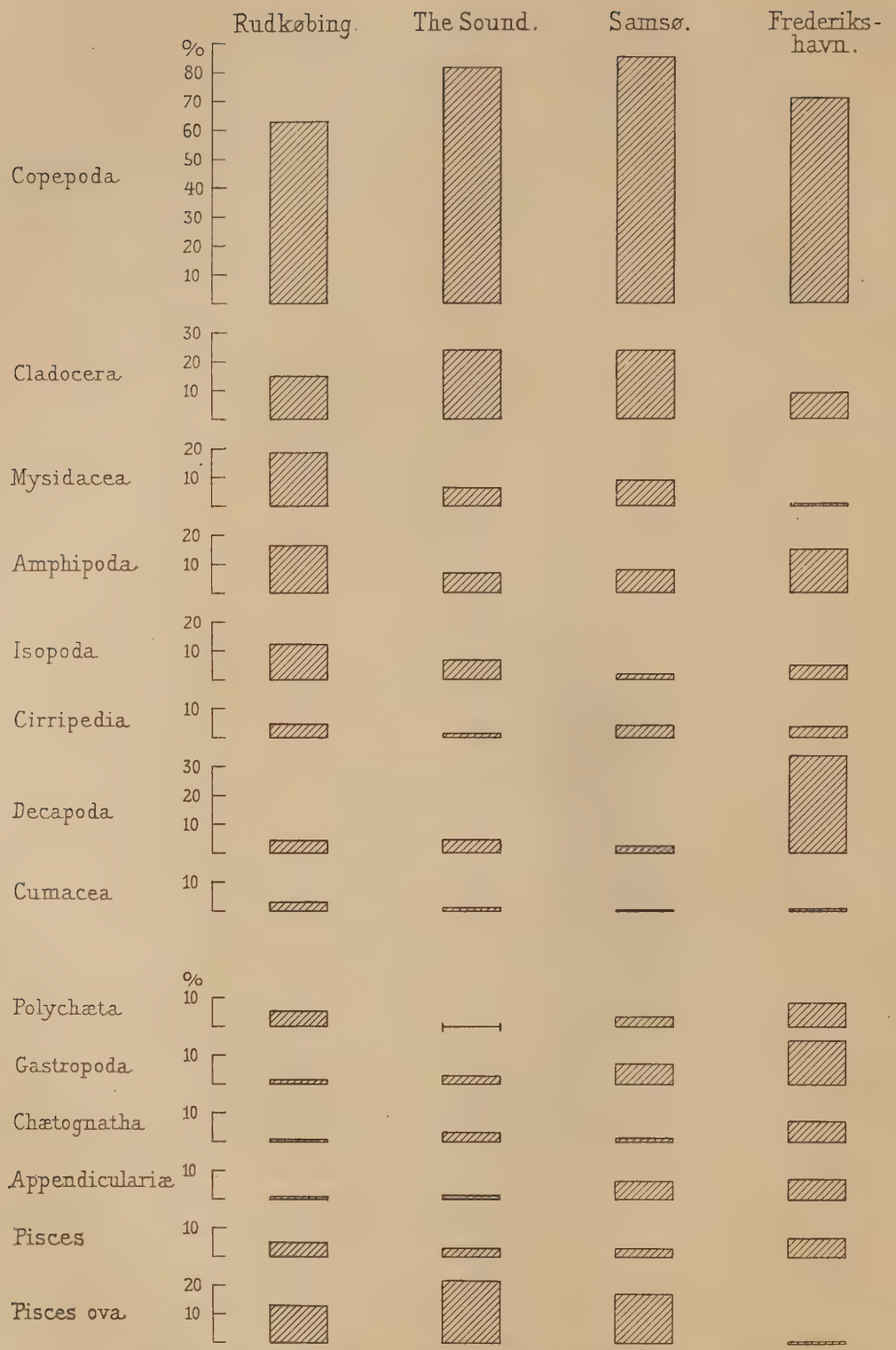


Fig. 9. Mean percentage of herring stomachs containing the principal groups of food organisms. Four localities inside the Skaw.

The results of the present investigations certainly suggest that the herring do not devour all plankton organisms indiscriminately, but exercise a selection. This agrees with a series of previous investigations concerning the food of the herring, e. g. Thomas Scott (1907, p. 269), Bullen (1912, p. 399), Hardy (1924, p. 28) and Kyle and Ehrenbaum (1927, p. 25). As a proof of this selection of certain organisms in preference to others may be noted the fact that in the present investigation of herring material, no remains of coelenterates or echinoderm larvæ were ever found in the food. The view is further supported by the fact that certain organisms such as for instance lamellibranch larvæ, bryozoa larvæ, *Sagitta* and appendicularians were often found in very small numbers in the stomach contents though they may have been abundant in the plankton at the time. The same applies also to the smaller copepods, e. g. the genus *Oithona*, which was often extremely numerous in the plankton samples, but was never found to any great number in the stomach contents of the herring.

We will now proceed to consider the occurrence of the different organisms in herring from the four localities mentioned. The object of this survey is more particularly to show the seasonal occurrence of the principal food organisms, and only those of some considerable importance as herring food will be further dealt with; detailed information as to the separate species may be found in Chapter III, where the material from the various localities is dealt with at length. In the following, the crustacea are taken first, and thereafter the various groups of non-crustaceous organisms found in the food.

Cladocera. Next to the copepods, the cladocerans are among the principal items in the food of the herring in Danish waters; their occurrence however, in contrast to that of the copepods, is very largely restricted to the warmer season.

Table 214. Mean monthly percentage of herring containing cladocerans for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	3.6	35.9	66.4	28.7	3.5	27.1	10.4	—	—
The Sound	—	x	4.8	11.1	x	50.0	35.0	52.5	24.1	32.4	5.4	x
Samsø	x	x	x	17.3	25.0	53.3	x	x	30.7	15.8	—	x
Frederikshavn	x	x	x	x	x	x	19.0	11.1	4.7	1.2	x	x

It is only from April to October that any great number of herring are found to contain cladocerans. At Rudkøbing, we observe a maximum in early summer and a decrease in the percentages later on. The Sound shows a fairly regular rise from March, and a decline from August to November.

The genera *Evadne* and *Podon* are the most important cladocerans at these localities excepting the Sound, where *Bosmina maritima* was numerically predominant. The relative number of specimens of the three genera noted in the stomach analyses for the four localities will be seen from the following, where the figures in parentheses indicate the number of specimens.

	Rudkøbing	The Sound	Samsø	Frederikshavn
Evadne	50.4 % (127)	29.0 % (733)	7.1 % (30)	12.0 % (6)
Podon	49.6 — (125)	13.0 — (327)	92.9 — (392)	88.0 — (44)
Bosmina	— —	58.0 — (1466)	— —	— —

At Rudkøbing, the genera *Evadne* and *Podon* are represented by approximately equal numbers, and in the Sound *Bosmina* takes the lead. *Evadne* shows twice the numbers of *Podon* in herring from the Sound, the latter genus however, is by far the more numerous in the material from Samsø and Frederikshavn.

Ostracoda. Only single specimens of these crustaceans are found, in two herring from the Sound; their importance as herring food is thus altogether insignificant.

Copepoda. As already noted, copepods are the organisms most frequently found in the food of the herring in Danish waters. A survey of the mean monthly percentage of herring containing copepods for the various localities is given in Table 215.

Table 215. Mean monthly percentage of herring containing copepods for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	100.0	97.3	42.9	81.0	86.9	70.4	33.3	47.6	60.7	75.0	23.9	29.8
The Sound	100.0	x	90.5	66.7	x	100.0	100.0	55.0	69.5	66.1	80.2	x
Samsø	x	x	x	97.2	94.0	86.7	x	x	68.7	76.7	82.8	x
Frederikshavn	x	x	x	x	x	x	52.4	77.8	68.7	81.5	x	x

The figures show extremely noticeable fluctuations, but it is impossible to discern any definite features in the variations. There is very little agreement, for instance, between the different localities. At Rudkøbing however, we noticed a great difference in the numbers of copepods found in the stomach contents at the different seasons, the highest figures being noted for winter and spring, the lowest for summer and autumn (see Table 24, p. 27).

Proceeding now to consider the importance of the various species of copepods as food for the herring, we find that there is some variation at the different localities. To give an idea as to which copepods are most important as herring food in the different waters, the total number of identifiable copepods from the stomach analyses has been taken, and the relative numerical values of the different species calculated (Table 216). The material from Rudkøbing, the Sound and Samsø is so extensive that it probably gives a fairly reliable view of the importance of the different copepods; that from Frederikshavn on the other hand is smaller (691 specimens) and covers only the summer and autumn months. In comparing the occurrence of the different species at the four localities therefore, the material from the three first will be the most important.

Table 216. Relative importance of the various copepods as herring food in the different localities.

(Figures in parentheses indicate number of specimens noted in the stomach analyses).

	Rudkøbing	The Sound	Samsø	Frederikshavn
	%	%	%	%
Calanus finmarchicus	0.070 (23)	0.014 (6)	1.304 (777)	5.499 (38)
Pseudocalanus + Paracalanus	34.222 (11309)	15.222 (6351)	80.679 (48072)	19.392 (134)
Centropages typicus	—	0.012 (5)	0.002 (1)	5.789 (40)
Centropages hamatus	7.750 (2561)	2.531 (1056)	3.038 (1810)	41.823 (289)
Isias clavipes	0.012 (4)	—	0.010 (6)	0.579 (4)
Temora longicornis	56.206 (18574)	43.020 (17949)	14.613 (8707)	17.077 (118)
Eurytemora hirundo	—	0.046 (19)	—	—
Anomalocera Patersoni	—	—	—	0.289 (2)
Labidocera Wollastoni	—	0.002 (1)	—	2.605 (18)
Acartia sp.	1.628 (538)	39.094 (16311)	0.233 (139)	3.763 (26)
Oithona sp.	0.018 (6)	0.002 (1)	0.010 (6)	0.434 (3)
Harpacticidæ	0.094 (31)	0.055 (23)	0.109 (65)	1.737 (12)
Caligus sp.	—	0.002 (1)	0.002 (1)	—
Corycæus anglicus	—	—	—	1.013 (7)

It will be seen that the most important copepods are *Pseudocalanus + Paracalanus* and *Temora longicornis*. To these must also be added, in one locality (Frederikshavn) *Centropages hamatus*, and in the Sound the genus *Acartia*. All the remaining copepods are of comparatively slight importance as herring

food. The relative values for the above mentioned copepods, and for all the rest, are shown graphically in Fig. 10.

It will be seen from the graph that *Temora* is numerically predominant both at Rudkøbing and in the Sound, whereas *Pseudocalanus* + *Paracalanus* are far in advance of the other copepods for the Samsø waters. At Frederikshavn, *Centropages hamatus* is found in greatest numbers, but the material from here is, as mentioned, only from the summer and autumn. It is interesting to note, that the genus *Acartia* is of considerable importance as food for the herring of the Sound compared with what is observed at the other localities.

We will now take some of the most important species of copepods and consider the average monthly percentage of herring containing these species at each locality.

Calanus finmarchicus. At Rudkøbing, this species only appears in the stomach contents of the herring in January and in April—June, never in autumn (Table 217). Something similar is observed in the Sound, but the species is here noted in 4.1 % of the herring from October. At Samsø, *Calanus* appears in the food both in spring and autumn, but the spring has far the higher figure. At Frederikshavn, the species is fairly common as food in the months covered by the investigations. In the inner Danish waters, *Calanus* is of but slight importance as food for the herring; the available data suggest however, that it is far more important in the northern Kattegat than in the southern Danish waters (see Table 216, p. 118).

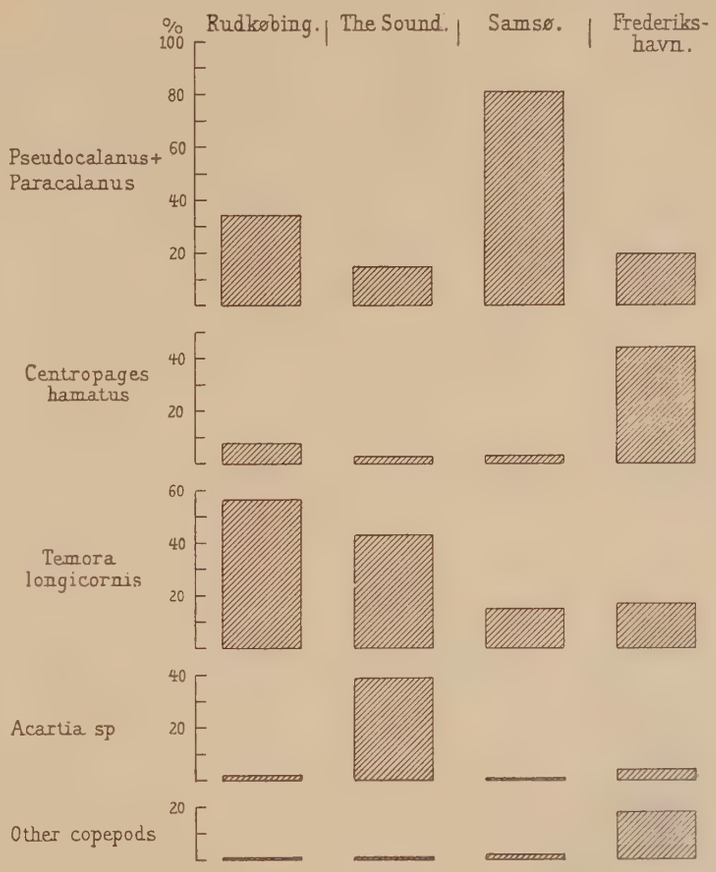


Fig. 10. Relative importance of various copepods as herring food in the different localities.

Pseudocalanus elongatus + *Paracalanus parvus.* The percentages of herring containing these two species will be seen from Table 218 (p. 120). At Rudkøbing, as also in the Sound and Samsø waters, we find the highest percentages in spring and early summer. At Rudkøbing, these species appear in November only in 1.6 % of the herring examined and in December none are noted at all in the stomach contents.

Table 217. Mean monthly percentage of herring containing Calanus finmarchicus for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	12.5	—	—	11.7	4.7	9.2	—	—	—	—	—	—
The Sound	—	x	4.8	11.1	x	—	5.0	—	—	4.1	—	x
Samsø	x	x	x	17.1	35.0	6.7	x	x	8.9	8.6	3.3	x
Frederikshavn	x	x	x	x	x	x	9.5	11.1	1.5	20.9	x	x

Table 218. Mean monthly percentage of herring containing Pseudocalanus + Paracalanus for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	50.0	67.6	14.3	47.9	66.6	63.7	5.5	40.5	28.0	47.2	1.6	—
The Sound	38.9	x	81.0	66.7	x	68.7	90.0	18.7	32.5	24.0	55.1	x
Samsø	x	x	x	92.6	78.0	80.0	x	x	59.7	52.2	26.6	x
Frederikshavn	x	x	x	x	x	x	14.3	33.3	31.2	36.9	x	x

Centropages hamatus. As with the other copepods, this species is chiefly important as herring food in spring and early summer (about March—July). This applies to all the three localities where investigations are made both in spring and autumn (Table 219.).

Table 219. Mean monthly percentage of herring containing Centropages hamatus for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	12.5	13.5	42.9	28.6	44.0	46.4	20.3	7.1	23.6	25.7	10.0	8.9
The Sound	11.1	x	38.1	44.4	x	68.7	70.0	17.5	5.7	17.8	31.3	x
Samsø	x	x	x	60.9	50.0	53.3	x	x	11.3	14.5	6.6	x
Frederikshavn	x	x	x	x	x	x	—	—	9.3	28.3	x	x

Temora longicornis. The average percentage of herring containing this species varies greatly for the different months, and there is no very marked agreement between the different localities in this respect (Table 220.). Rudkøbing shows high values for January and February, with a more or less gradual decline thenceforward for the rest of the year. The percentages for the Sound are very irregular, but there seems to be a fairly distinct minimum during Aug., Sept. and October. Samsø has a far higher percentage in spring than in autumn, viz. on an average 66.6 % and 20.6 % respectively. Generally speaking, this species is of most importance as herring food in the first half of the year. It is worth noting that *Temora*, unlike most copepods, appears in great numbers in the food of the herring — at any rate as regards Rudkøbing and the Sound — in the winter months of January—March.

Table 220. Mean monthly percentage of herring containing Temora longicornis for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	75.0	86.5	42.9	57.8	55.0	36.0	12.9	10.7	26.2	7.6	20.5	28.0
The Sound	88.9	x	85.7	11.1	x	81.2	100.0	36.2	34.6	43.0	71.3	x
Samsø	x	x	x	65.6	68.0	73.3	x	x	20.0	17.5	17.1	x
Frederikshavn	x	x	x	x	x	x	38.1	77.8	20.3	31.2	x	x

Acartia sp. Copepods of the genus *Acartia* are on the whole of chief importance as herring food in spring and early summer. Table 221 shows the predominance of *Acartia* as food in the Sound as compared with the other waters. The percentages for the Sound show a minimum in August—September, but there is then a rather marked increase in October—November. At Samsø and Frederikshavn also there seems to be a slight increase in the percentage in autumn.

Table 221. Mean monthly percentage of herring containing Acartia for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	25.0	24.3	14.3	36.0	35.4	30.2	5.5	3.5	2.4	7.6	—	1.8
The Sound	5.6	x	52.4	55.6	x	87.5	85.0	25.0	18.8	40.9	65.3	x
Samsø	x	x	x	17.4	16.0	26.7	x	x	5.8	15.4	38.1	x
Frederikshavn	x	x	x	x	x	x	—	—	14.0	16.8	x	x

Cirripedia. Cirripede larvæ serve only to a slight extent as food for the herring; in some months however, they are found in the stomachs of a fairly considerable number of the herring examined.

Table 222. Mean monthly percentage of herring containing cirripede larvæ for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	5.4	—	26.6	7.8	2.9	—	—	—	5.6	5.5	1.8
The Sound	—	x	—	—	x	—	—	—	—	1.0	11.7	x
Samsø	x	x	x	17.1	3.0	—	x	x	—	4.8	—	x
Frederikshavn	x	x	x	x	x	x	—	—	—	14.5	x	x

Herring from Rudkøbing and Samsø are only found to contain cirripede larvæ in spring and autumn, and the fish from the Sound only in autumn. At none of the four localities are any cirripede larvæ found in the stomach contents of herring from July, August or September, which indicates a marked seasonal occurrence and agrees with the occurrence of the cirripede larvæ in the plankton. The so-called cypris stage seems to be more sought after by the herring than the nauplius stage.

Mysidacea. As previously noted, the mysids constitute an essential portion of the food of the herring in several of the waters covered by the investigations. The monthly percentages are shown in Table 223.

At Rudkøbing, mysids appear in the food in nearly all the months of the year, but in November and December especially, the percentage of herring containing mysids is very considerable. Altogether, we find higher percentages for the second half of the year than for the first. In herring from the Sound, small quantities of mysids are noted in January and March, considerably more in autumn, but none in the summer months. At Samsø, mysids are found in the stomach contents of by far the greater number of herring in autumn. At Frederikshavn, mysids are of but the very slightest importance as food. Rudkøbing is thus unquestionably the locality where mysids are of most account in the food of the herring.

Table 223. Mean monthly percentage of herring containing mysids for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	2.7	14.3	3.0	4.3	15.9	39.8	20.2	15.5	11.8	47.2	47.6
The Sound	5.6	x	9.5	—	x	—	—	—	12.2	15.8	13.7	x
Samsø	x	x	x	4.6	—	6.7	x	x	4.4	18.3	20.5	x
Frederikshavn	x	x	x	x	x	x	4.8	—	—	—	x	x

As regards the localities Rudkøbing, the Sound and Samsø, we may say that mysids are most important in the autumn. This agrees well with investigations concerning the food of the herring in the Baltic. Hessle (1925, p. 27) for instance, writes: "It seems, however, to be chiefly in the latter part of the summer and in the autumn that *Mysis* forms a considerable part of the food of the herrings."

To give an idea as to which species of mysids are more particularly found in the food, the relative numbers of the different species found in the stomach analyses from the various localities are noted below.

Table 224. Relative importance of the various mysids as herring food in the different localities.

(Figures in parentheses indicate number of specimens noted in the stomach analyses.)

	Rudkøbing	The Sound	Samsø	Frederikshavn
	%	%	%	%
Gastrosaccus spinifer	33.8 (193)	27.4 (63)	8.0 (27)	—
Leptomysis gracilis	—	0.9 (2)	—	—
Macropsis Slabberi	0.5 (3)	2.6 (6)	16.9 (57)	—
Macromysis inermis	30.8 (176)	10.0 (23)	0.3 (1)	—
— flexuosa	15.1 (86)	11.3 (26)	0.3 (1)	—
— neglecta	9.5 (54)	23.5 (54)	—	—
Schistomysis spiritus	10.0 (57)	—	74.5 (252)	100.0 (4)
— ornata	0.3 (2)	0.4 (1)	—	—
Michtheimysis mixta	—	23.0 (53)	—	—
Neomysis vulgaris	—	0.9 (2)	—	—

Both at Rudkøbing and in the Sound, *Gastrosaccus spinifer* is numerically predominant. At Samsø, on the other hand, *Schistomysis spiritus* shows a large majority, and this species is the only mysid found in the stomach contents of the herring at Frederikshavn. The most important species, after those above named, are, at Rudkøbing *Macromysis inermis*, in the Sound *Macromysis neglecta* and *Michtheimysis mixta*, and at Samsø *Macropsis Slabberi*.

Decapoda. These are represented in the stomach contents of the herring mainly by larval stages, the adults being only exceptionally met with. The principal decapod larvæ serving as food for the herring in the inner Danish waters are those of crabs and *Crangon*. The average monthly percentages of herring containing decapod larvæ are shown in Table 225.

Table 225. Mean monthly percentage of herring containing decapod larvæ for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	—	2.9	12.9	1.8	20.2	7.5	—	1.6	—
The Sound	—	x	—	—	x	—	5.0	25.0	6.5	—	—	x
Samsø	x	x	x	—	1.0	—	x	x	7.1	5.2	—	x
Frederikshavn	x	x	x	x	x	x	38.1	33.3	50.0	13.9	x	x

It is fairly evident that decapod larvæ serve as food for the herring mainly in summer and to some extent in autumn. As the table shows the decapod larvæ are most important as food at Frederikshavn. Adult decapods include a few specimens of *Crangon vulgaris* and *Palæmon Fabricii*.

Cumacea. As will be seen from Table 226, the cumacea appear during most months only in a comparatively small number of the herring examined. At Rudkøbing, where they seem to be chiefly taken as food, they are found especially during the period from July to November.

In herring from Rudkøbing and the Sound, the only species identified with certainty is *Diastylis Rathkei*; in herring from Samsø, *Lamprops fasciata*, and in those from Frederikshavn a single specimen of *Pseudocuma longicorne*.

Table 226. Mean monthly percentage of herring containing cumacea for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	—	1.4	—	1.8	20.2	2.4	2.1	8.3	—
The Sound	5.6	x	—	—	x	—	—	—	—	5.2	—	x
Samsø	x	x	x	0.9	—	—	x	x	—	—	—	x
Frederikshavn	x	x	x	x	x	x	—	—	—	1.2	x	x

Isopoda. Isopods are of considerable importance as food for the herring in Danish waters (Table 227), and appear to be most numerous in the inner localities (Rudkøbing, The Sound). At Rudkøbing, isopods are noted in March in the stomach contents of 28.6 % of the herring examined, but apart from this they are only found in the food from July to December; in the Sound, they appear also to be taken as food chiefly in the latter half of the year.

Table 227. Mean monthly percentage of herring containing isopods for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	28.6	—	—	—	34.2	23.8	8.1	10.4	29.4	10.1
The Sound	5.6	x	4.8	—	x	—	—	10.0	8.9	25.4	6.6	x
Samsø	x	x	x	6.2	—	—	x	x	1.1	0.8	3.8	x
Frederikshavn	x	x	x	x	x	x	4.8	—	—	16.5	x	x

All the isopods found in the food of the herring in the various localities mentioned are, save for a single exception, of the genus *Idothea*; the only species identified with certainty are *Idothea baltica* and *I. viridis*. The only other isopod found is a single specimen of *Eurydice pulchra* in the stomach of a herring from Rudkøbing.

Amphipoda. In one locality (Rudkøbing) amphipods are among the most important crustacea in the food. Taking the percentages of Rudkøbing herring containing amphipods (Table 228), it will be seen that the figures for January—June are very low. In most months of the latter half of the year however, amphipods are found in quite a considerable number of the herring examined, in November and December especially.

Table 228. Mean monthly percentage of herring containing amphipods for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	2.7	—	1.8	—	2.9	11.1	27.3	20.2	2.1	55.0	70.3
The Sound	5.6	x	19.0	—	x	6.2	—	—	12.7	10.5	8.1	x
Samsø	x	x	x	—	1.0	13.3	x	x	1.1	4.8	28.1	x
Frederikshavn	x	x	x	x	x	x	28.6	—	6.2	24.3	x	x

In the food of herring from the Sound, amphipods are far less numerous than in that of the Rudkøbing fish. At Samsø, the greatest number of herring containing amphipods are found in November, and at Frederikshavn we find considerable quantities in July and October.

Endeavouring now to form an impression, from the material available, as to the relative importance of the various amphipods as food (Table 229), we must confine ourselves to consideration of the genera, as in many cases it was impossible to determine the species.

The material here available is but scanty, especially in the case of Samsø; nevertheless, it seems evident from the table that *Gammarus* is by far the most important genus of amphipods in all four localities. None of the other genera can show anything like the same figures.

Table 229. Relative importance of the various genera of amphipods as herring food in the different localities.

(Figures in parentheses indicate number of specimens noted in the stomach analyses.)

	Rudkøbing	The Sound	Samsø	Frederikshavn
	%	%	%	%
Hyperia	—	—	—	11.4 (8)
Themisto	—	—	—	5.7 (4)
Pontoporeia	1.1 (8)	—	11.1 (2)	—
Bathyporeia	0.3 (2)	0.8 (1)	—	—
Apherusa	9.6 (67)	—	—	—
Calliopius	0.3 (2)	12.2 (15)	5.6 (1)	—
Nototropis	—	—	16.7 (3)	4.3 (3)
Gammarellus	0.1 (1)	—	—	—
Gammarus	85.1 (593)	85.4 (105)	66.6 (12)	74.3 (52)
Melita	—	0.8 (1)	—	—
Ischyrocerus	0.9 (6)	—	—	4.3 (3)
Corophium	2.6 (18)	0.8 (1)	—	—

Polychæta. The occurrence of polychætes in the food varies somewhat for the different months and in the different localities (Table 230.). They are found in all the waters here concerned except the Sound, where no polychætes have ever been noted in the stomach contents.

Table 230. Mean monthly percentage of herring containing polychætes for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	14.3	6.0	19.4	—	3.7	17.8	2.4	—	1.6	—
The Sound	—	x	—	—	x	—	—	—	—	—	—	x
Samsø	x	x	x	10.3	3.0	—	x	x	1.1	5.3	—	x
Frederikshavn	x	x	x	x	x	x	28.6	—	—	3.9	x	x

It will be seen from the table that there are great fluctuations in the occurrence of the polychætes in the food; there can be little doubt however, that their maximum lies in spring and summer (March—August), the percentage of herring containing polychætes in autumn, and especially in winter, being very low indeed.

Gastropoda. These are represented in the food almost exclusively by larval stages, adults being only exceptionally found. The occurrence of larval gastropods in the food of the herring is of a decidedly seasonal character, falling in the period from June to November (Table 231), which agrees well with their occurrence in the plankton samples from the different localities. The gastropod larvæ seem to bulk more largely in the food at Samsø and Frederikshavn than at Rudkøbing and in the Sound.

Table 231. Mean monthly percentage of herring containing larval gastropods for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	—	—	6.6	3.7	—	2.4	—	2.8	—
The Sound	—	x	—	—	x	—	—	—	6.1	2.1	15.8	x
Samsø	x	x	x	—	—	6.7	x	x	15.9	20.6	—	x
Frederikshavn	x	x	x	x	x	x	—	33.3	1.5	24.3	x	x

Lamellibranchiata. Lamellibranch larvæ are of very slight importance in the food. At Rudkøbing and Frederikshavn for instance, none are ever met with in the stomach analyses, and the herring from the Sound show only a small percentage in July and August, viz. 5.0 and 6.2 %. In October, a solitary specimen is found in the stomach of a herring from Samsø. Evidently then, larval stages of lamellibranchs, though sometimes fairly common in the plankton, serve only to a very slight extent as food for adult herring.

Bryozoa. In the plankton samples, bryozoa larvæ — *Cyphonautes* — often occur in considerable numbers; despite this fact, however, it is extremely rare to find them in the stomach contents of the herring. In all our present material of adult herring, they are found only in a single instance, a fish from Samsø containing 3 specimens.

Chætognatha. At the four localities covered by these investigations, *Sagitta* appears in the plankton samples for most months of the year, but with a pronounced maximum in late summer and autumn. Correspondingly, *Sagitta* is only found in the food of the herring at this time of year, as shown in Table 232.

Table 232. Mean monthly percentage of herring containing Sagitta for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	—	—	—	—	7.1	—	—	—	—
The Sound	—	x	—	—	x	6.2	—	6.2	6.7	8.3	4.0	x
Samsø	x	x	x	—	—	—	x	x	3.8	4.1	—	x
Frederikshavn	x	x	x	x	x	x	—	22.2	—	6.6	x	x

Compared with the great quantities often noted in the plankton samples, we find relatively few herring containing *Sagitta*, which suggests that these organisms are not particularly sought after by the herring as food.

Appendiculariæ. Appendicularians are fairly common at times in the stomach analyses (Table 233.).

Table 233. Mean monthly percentage of herring containing Oikopleura for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	—	—	—	—	—	—	5.6	—	—
The Sound	—	x	—	—	x	—	—	—	—	—	10.9	x
Samsø	x	x	x	—	—	—	x	x	3.3	13.3	20.0	x
Frederikshavn	x	x	x	x	x	x	—	11.1	4.7	13.9	x	x

The only genus identified with certainty is *Oikopleura*, and this only appears in the food from August to November. This agrees with the occurrence of *Oikopleura* in the plankton samples, where we find a pronounced maximum in autumn. The species *Oikopleura dioica* is extremely common in autumn in the Sound and at Rudkøbing, but only appears in the food of a relatively small number of herring; we may take it then, that these organisms are not greatly sought after by the herring as food.

Pisces. Both fish — especially young stages — and fish eggs are often of considerable importance as herring food. Table 234 shows the mean monthly percentage of herring with fish in the stomach.

Table 234. Mean monthly percentage of herring containing fish for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	—	—	—	—	—	9.2	9.2	30.9	7.1	2.1	2.8	1.8
The Sound	5.6	x	—	—	x	—	—	5.0	11.2	2.1	5.7	x
Samsø	x	x	x	—	1.0	—	x	x	16.9	—	—	x
Frederikshavn	x	x	x	x	x	x	9.5	11.1	1.5	4.0	x	x

Fish seem to occur in the diet especially in summer and autumn, and to some extent also in winter; in spring on the other hand they are of but the very slightest importance at the three localities where investigations were made at this season. At Rudkøbing and in the Sound, it is mostly young *Ammodytes* which we find in the food; young stages of *Clupea*, however, are also found (presumably *Clupea sprattus*) and a few *Gobius sp.* At Samsø also, a few *Ammodytes* are found in the food, but the great majority are larval and post-larval stages of herring. All the fish which could be identified in the stomach contents from Frederikshavn were young *Ammodytes*. From these investigations it appears then, that young stages of *Ammodytes* and *Clupea* are the principal fish items in the food of the herring in Danish waters.

At all localities, with the exception of Frederikshavn, fish eggs are occasionally found in a considerable number of the herring examined.

Table 235. Mean monthly percentage of herring containing fish eggs for the different localities.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Rudkøbing	37.5	8.1	14.3	22.5	10.4	29.8	3.7	—	5.7	18.1	1.6	—
The Sound	—	x	47.6	55.6	x	50.0	35.0	—	3.5	3.2	—	x
Samsø	x	x	x	1.8	27.0	13.3	x	x	47.1	16.4	—	x
Frederikshavn	x	x	x	x	x	x	—	—	—	1.4	x	x

In some months, fish eggs appear in the stomach contents of about half the herring with any food at all; for the rest, the percentages vary greatly for the different months. A peculiar feature is the comparative insignificance of fish eggs in the food of the herring from Frederikshavn. Most of the fish eggs found in the food are herring eggs, and we observe two seasons for these, corresponding respectively to the spawning seasons of the spring- and autumn-spawning herring. In Jan.—Feb., it is mainly eggs of pleuronectids which are found in the food of the herring at Rudkøbing; a considerable quantity of the eggs found in the stomach contents however, were beyond identification.

Vegetable Food. Remains of *Zostera* and algæ are occasionally found in the stomachs of the herring, but the quantities are so small that the presence of such matter must probably be regarded as accidental. Phytoplankton has only exceptionally been found under such conditions as to suggest that the herring had taken the organisms in question directly as food. In the case of adult herring at any rate, vegetable diet is altogether insignificant in comparison with animal food.

4. Food of young herring compared with that of adults.

There is a small amount of material of young herring from Rudkøbing and from Frederikshavn, collected at the same time as samples of adult herring, and we have thus an opportunity of comparing the food of the young fish with that of the adults. There is also a small amount of material from Samsø, but as this is taken from several samples, it will not be included here.

We will first of all consider the material from Rudkøbing, which consists of three samples from the $^{31}/_{1}$ 26, $^{5}/_{6}$ 24 and $^{10}/_{9}$ 25 respectively. In view of the difference of season, it is hardly warrantable to take the three samples together; we are therefore obliged, despite the small numbers of fish concerned, to take the individual samples separately. First then, we take the relative quantities of young herring and adults containing food, the values for the three samples appearing as follows:

	$^{31}/_{1}$ 26	$^{5}/_{6}$ 24	$^{10}/_{9}$ 25
Young herring (9—17 cm. length)	100.0 % (9 : 9)	91.7 % (11 : 12)	100.0 % (8 : 8)
Adult herring (18—26 cm. length)	58.3 % (7 : 12)	71.4 % (10 : 14)	18.2 % (2 : 11)

It will be noticed that the relative number of young herring containing food is very considerably in excess of that for adults with food. We will now proceed further to investigate the composition of the food in the two groups. Table 236 in which are included only herring with definite stomach contents, shows, for the three samples mentioned, and for young herring and adults respectively, the percentage of herring containing the different groups of organisms, and the average number of organisms per herring.

Table 236. Showing, for young and adult herring respectively from Rudkøbing, I) Percentage of herring containing the different groups of organisms, and II) Average number of organisms per herring containing the respective organisms.

	I.						II.					
	Jan. 31, 1926		June 5, 1924		Sept. 10, 1925		Jan. 31, 1926		June 5, 1924		Sept. 10, 1925	
	11—17 cm.	18—25 cm.	11—15 cm.	19—24 cm.	9—11 cm.	21—26 cm.	11—17 cm.	18—25 cm.	11—15 cm.	19—24 cm.	9—11 cm.	21—26 cm.
Copepoda	100.0 (9 : 9)	100.0 (7 : 7)	100.0 (11 : 11)	80.0 (8 : 10)	100.0 (8 : 8)	100.0 (2 : 2)	68 (611 : 9)	24 (169 : 7)	143 (1574 : 11)	2 (18 : 8)	25 (200 : 8)	3 (6 : 2)
Cladocera	—	—	72.7 (8 : 11)	10.0 (1 : 10)	62.5 (5 : 8)	—	—	—	12 (97 : 8)	1 (1 : 1)	2 (8 : 5)	—
Mysidacea	22.2 (2 : 9)	—	—	—	—	—	1 (2 : 2)	—	—	—	—	—
Cirripedia	11.1 (1 : 9)	—	—	—	—	—	2 (2 : 1)	—	—	—	—	—
Chætognatha	—	—	—	—	25.0 (2 : 8)	—	—	—	—	—	1 (2 : 2)	—
Appendiculariæ ...	—	—	—	—	50.0 (4 : 8)	—	—	—	—	—	2 (9 : 4)	—
Pisces	—	—	—	20.0 (2 : 10)	—	—	—	—	—	1 (2 : 2)	—	—
Pisces ova	44.4 (4 : 9)	42.9 (3 : 7)	18.2 (2 : 11)	70.0 (7 : 10)	—	—	2 (8 : 4)	4 (12 : 3)	1 (2 : 2)	3 (18 : 7)	—	—

From this it will be seen that copepods are found in nearly all herring containing food, but that the average number of copepods per fish is far greater among the young herring than among the adults. Cladocerans likewise show by far the highest averages for young herring. Mysids, cirripede larvæ, chætognaths and appendicularians appear only in a single sample, and only in young herring. Fish are only found in the food of adult herring, and fish eggs seem on the whole to be somewhat more numerous among the adults than among the young herring.

The material of young herring and adults from Frederikshavn, which was collected in October 1923, consists of 46 young fish (12—15 cm.) and 72 adults (17—24 cm.). Of the former, 95.7 % (44 specimens) and of the latter 50 % (36 specimens) are found to contain food. The percentage of herring containing the different groups of organisms, and the average number of organisms per fish will be seen from the accompanying Table 237.

The most pronounced difference appears in the case of larval gastropods, which are found in the stomach contents of 79.5 % of the young herring, but only in 11.1 % of the adults examined. The averages

show that larval gastropods are at times found in comparatively great numbers in the adult herring, but from Fig. 6, p. 92 it will be seen that they were only found in the food of the smallest sized adults (17—18 cm.). In the present material, cladocerans, cirripede larvæ and lamellibranch larvæ appear only in the food of the young herring, never in that of the adults, and the average number of copepods per young herring is here — as at Rudkøbing — far in excess of the corresponding figure for adults.

Table 237. Showing, for young and adult herring respectively from Frederikshavn October 1923, I) Percentage of herring containing the different groups of organisms, and II) Average number of organisms per herring containing the respective organisms.

	I.		II.	
	12—15 cm.	17—24 cm.	12-15 cm.	17—24 cm.
Copepoda	84.1 (37 : 44)	80.6 (29 : 36)	45 (1665 : 37)	3 (94 : 29)
Cladocera	9.1 (4 : 44)	—	9 (37 : 4)	—
Amphipoda	6.8 (3 : 44)	11.1 (4 : 36)	3 (10 : 3)	1 (4 : 4)
Isopoda	6.8 (3 : 44)	5.6 (2 : 36)	2 (5 : 3)	3 (7 : 2)
Cirripedia	4.5 (2 : 44)	—	1 (2 : 2)	—
Decapoda	9.1 (4 : 44)	27 8 (10 : 36)	3 (11 : 4)	2 (17 : 10)
Polychæta	—	2.8 (1 : 36)	—	1 (1 : 1)
Gastropoda	79.5 (35 : 44)	11.1 (4 : 36)	129 (4521 : 35)	15 (61 : 4)
Lamellibranchiata	2.3 (1 : 44)	—	2 (2 : 1)	—
Chætognatha	—	8.3 (3 : 36)	—	1 (4 : 3)
Appendiculariæ	13.6 (6 : 44)	2.8 (1 : 36)	4 (23 : 6)	5 (5 : 1)
Pisces	4.5 (2 : 44)	5.6 (2 : 36)	1 (2 : 2)	10 (21 : 2)
Pisces ova	—	2.8 (1 : 36)	—	5 (5 : 1)

Having thus compared the composition of the food of young herring and adults from two different localities in the Danish waters, the following points of difference appear to be most conspicuous: Young herring are more keen in their search for food than are the adults. In accordance with this, the average numbers of the different organisms, and especially of the copepods, are as a rule far greater among the young fish than among the adults. The following organisms seem to be more sought after by young herring than by adults: Cladocerans, cirripede larvæ, gastropod larvæ and appendicularians. Fish and fish eggs on the other hand, appear to serve as food for the adult herring to a greater extent than for the young ones.

5. Investigations as to feeding at different times of the day and night.

It would naturally be interesting to ascertain whether the herring feed equally at all times throughout the twenty-four hours or whether they have any particular feeding time. The question might possibly be decided by keeping herrings alive in aquaria, but as we had here no opportunity for such aquarium experiments, another method was employed. The marine research vessel "Dana" has been stationed at Esbjerg for several winters, and collections of young herring (length 6—15 cm.) were repeatedly made from the vessel at different times of the day and night; the stomach contents were then examined with

a view to ascertaining whether more food was to be found at one time than another. The results of these experiments are noted briefly below.

At Graadyb, outside Esbjerg, a series of hauls were made with the young fish trawl at different times of the day and night, the implement being worked close to the bottom in 10—12 m. of water. These experiments were carried out on three occasions, 11—12 Dec. 1924, 26 Jan. 1925 and 1—2 March 1926. The times, and numbers of fish examined from the different hauls, will be seen from Table 238 below.

Table 238. Times at which hauls were made with the young fish trawl, and numbers of young herring examined from the respective hauls. Graadyb.

	2—3 P. M.	6—7 P. M.	10—11 P. M.	Midnight. 12—1 A. M.	2—3 A. M.	5—6 A. M.	8—9 A. M.	10—11 A. M.	Noon. 12—1 P. M.	2—3 P. M.
Dec. 11—12, 1924	29	..	5	..	8	..	..	65	..	84
Jan. 26, 1925	75	..	23	..	..	..	..	..	..	..
March 1—2, 1926	59	69	..	16	..	48	56	46	12	..

From this it will be seen that on the 11—12 Dec. 1924, two hauls were made at night and three by daylight. Two of the daylight hauls were made at the same time (2—3 p. m.) on the 11 and 12 Dec. respectively. On the 26 Jan. 1925, only two hauls were made, one in the afternoon and one in the evening between 10 and 11; finally, on the 1—2 March, one haul was made at midnight, one in the evening at twilight (6—7 p. m.), one in the first of the daylight (5—6 a. m.) and 4 hauls in the forenoon and the afternoon.

To give an idea as to the times at which feeding chiefly takes place, we will examine the relative number of herring with food in the stomach from each haul. Table 239 below shows the percentages for the different hauls, and the values found are shown graphically in Fig. 11, p. 130.

Table 239. Percentages of herring containing food at different times of the day and night.

	2—3 P. M.	6—7 P. M.	10—11 P. M.	Midnight. 12—1 A. M.	2—3 A. M.	5—6 A. M.	8—9 A. M.	10—11 A. M.	Noon. 12—1 P. M.	2—3 P. M.
Dec. 11—12, 1924	100.0 (29 : 29)	..	80.0 (4 : 5)	..	62.5 (5 : 8)	..	..	89.2 (58 : 65)	..	96.4 (81 : 84)
Jan. 26, 1925	96.0 (72 : 75)	..	82.6 (19 : 23)	..	..	..	..	..	..	
March 1—2, 1926	98.3 (58 : 59)	94.2 (65 : 69)	..	68.7 (11 : 16)	..	68.7 (33 : 48)	60.7 (34 : 56)	87.0 (40 : 46)	91.7 (11 : 12)	

It will be seen from the figure that the period from 2—3 p. m. to midnight showed a marked decrease in the number of herring with food. This applies to all three experiments. A rise in the curve is first apparent in the morning, about 10 a. m. This is very distinctly evident in the experiment of 1—2 March 1926, where a haul made at 8—9 a. m. showed food only in 60.7 %, whereas one made at 10—11 a. m. contained 87.0 % with food. These experiments show that considerably more herring are found to contain food during the day than at night, and there can thus be little doubt that feeding takes place mainly while it is light.

As copepods were by far the most important organisms in the food of the young herring from Graadyb, we may take the average numbers of copepods per fish noted in the different hauls, which give

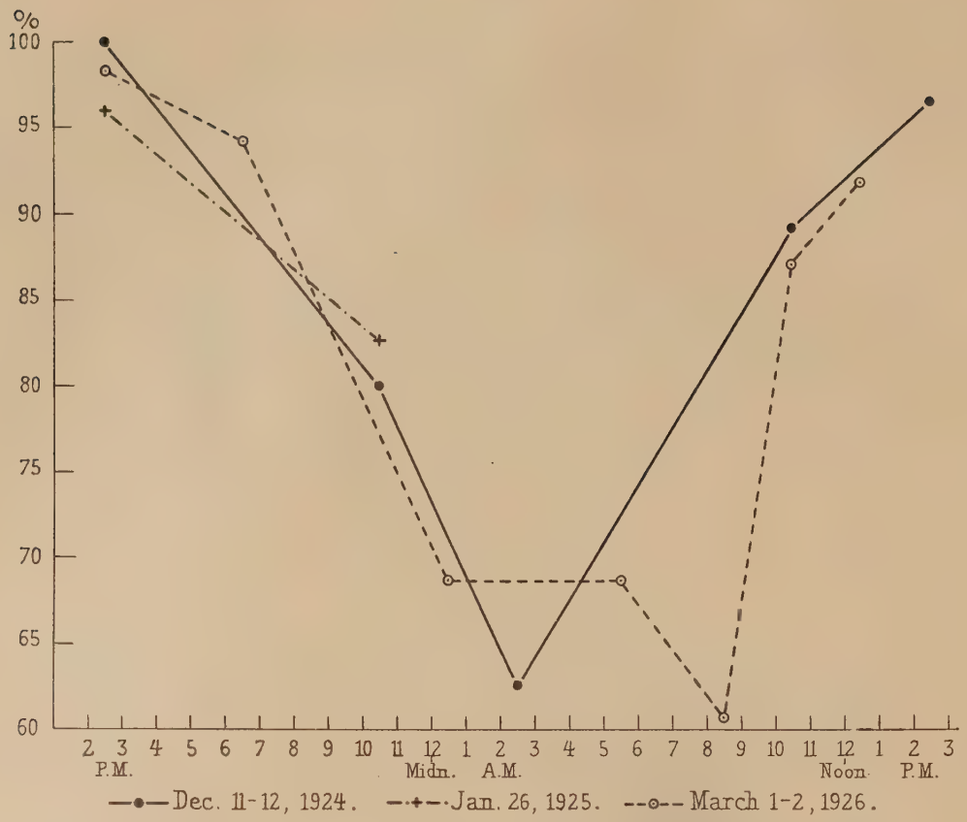


Fig. 11. Percentages of herring containing food at different times of the day and night.

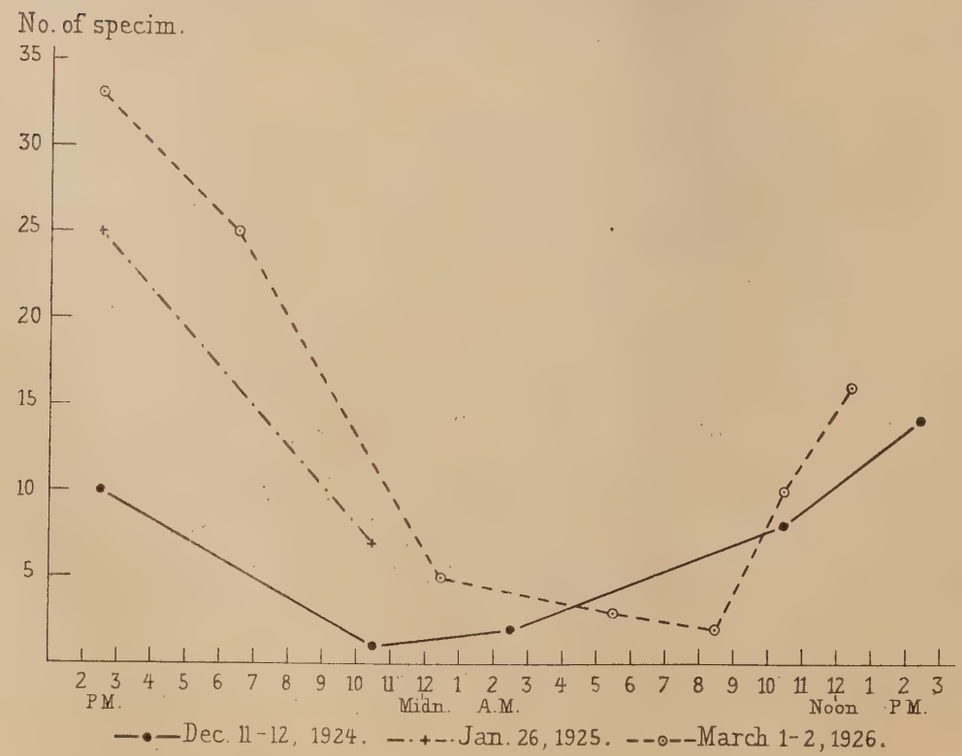


Fig. 12. Average number of copepods per herring at different times of the day and night.

a fairly good impression of the quantity of food in the stomachs at the different times of day and night. The averages will be seen from Table 240 and the values are shown graphically in Fig. 12, p. 130.

Table 240. Average number of copepods per herring at different times of the day and night.

	2—3 P. M.	6—7 P. M.	10—11 P. M.	Midnight. 12—1 A. M.	2—3 A. M.	5—6 A. M.	8—9 A. M.	10—11 A. M.	Noon. 12—1 P. M.	2—3 P. M.
Dec. 11—12, 1924	10 (301 : 29)	..	1 (5 : 4)	..	2 (14 : 8)	..	..	8 (511 : 65)	..	14 (1187 : 84)
Jan. 26, 1925.....	25 (1912 : 75)	..	7 (165 : 23)	..	..	..	..	..	..	..
March 1—2, 1926	33 (1945 : 59)	25 (1740 : 69)	..	5 (76 : 16)	..	3 (146 : 48)	2 (139 : 56)	10 (456 : 46)	16 (194 : 12)	..

It will be noted that the lowest averages are for the night time and the highest during the day. The curves seem to suggest that the greatest numbers are found in the afternoon, which is natural in view of the assumption that feeding takes place chiefly while it is light.

Generally speaking, the curves in this figure agree fairly well with those of Fig. 11. Both figures tend to show that the young herring in the winter time feed mainly during the day, and that no feeding, or at any rate, very little, takes place during the night.

The feeding of herring at different times of the day and night has been very little touched on in the literature. The only work dealing with this question, as far as the present writer is aware, is a paper by Lissner (1925) dealing with investigations on the feeding both of the Skagerrak herring and of the autumn-spawning herring in the western North Sea. The method used here, was the examination of the stomach contents of herring captured at different times of the day and night. In the case of the Skagerrak herring, it was observed that full stomachs might be found at all times, whereas the autumn-spawning herring of the North Sea seemed to have their particular feeding times. As regards these last, Lissner writes (*l. c.*, p. 208) that these herring seem to begin feeding in the afternoon, probably when the light begins to grow a little weaker, and that they cease feeding again after midnight, or towards morning. Lissner's results are thus not altogether in agreement with those of the present investigations from Graadyb; it must be borne in mind, however, that the herring from the western North Sea were adult fish, whereas ours from Graadyb were young herring, and that the investigations in the two places were carried out at different times of year, which are circumstances that can possibly explain the somewhat divergent results.

In support of the foregoing investigations, it would be most valuable to have some knowledge as to the time occupied by the herring in digesting its food. A series of experiments were made with the young herring from Graadyb, with this end in view. Freshly-caught and living herring were placed in tubs filled with sea water, the water being filtered through fine gauze, and renewed every hour. At intervals of a few hours, a batch of the fish would be killed, and their stomach contents compared with those of herring killed immediately after capture. Batches of herring from the tubs were killed and examined after being left for 3, 6, 9, 12, 15, 18, 21 and 24 hours respectively in the filtered water, where they would be unable to take in organisms of any size, such as copepods for instance, as food. In this way it should be possible to form some idea as to the length of time elapsing from the moment of feeding to the time when the food has passed out of the stomach. The experiments showed that food remained for a surprisingly long time in the stomach, the quantity of food moreover, being but very slightly reduced during the first 12—15 hours. Even after a lapse of 21—24 hours, several of the fish were still found to have food in the stomach, and a few specimens examined after 29, and in one case as long as 39 hours from the time of capture, had still a very small quantity of copepods in the stomach.

The above mentioned investigations on feeding at different times of the day and night show considerable variation within the 24 hours' range, and these artificial experiments are therefore probably

of no great significance. It was found very difficult to keep the herring alive for any length of time in the tubs, and the question at once suggests itself whether the unnatural conditions under which they were kept may not have affected the processes of digestion; if such were the case, the experiments yield no result comparable with what would be found in a state of nature.

V. Principal Organisms in the Food of the Herring in Danish Waters and elsewhere.

In endeavouring here to make a comparison between the principal organisms in the food of the herring in Danish waters and those of other seas, we shall confine ourselves to investigations dealing with the adult fish. Extant literature contains but little in the way of detailed information of a quantitative nature on the food of the herring, and comparison between the conditions prevailing in different waters will therefore be based on such data as show which organisms are most frequently met with as herring food.

The results of the present investigations in Danish waters will here, for the sake of convenience, be given in summary form, taking the material from the four localities: Rudkøbing, The Sound, Samsø and Frederikshavn, and calculating the average percentage of herring in which the various groups of organisms appeared as food (calculations based on the values in Table 213, p. 115). We thus obtain a general impression as to the occurrence of the different organisms in the food of the herring. The average percentages of herring in Danish waters containing the various groups of organisms were as follows: *Copepoda* $74._4$, *Cladocera* $17._8$, *Pisces ova* $13._0$, *Amphipoda* $11._5$, *Decapoda* $11._2$, *Mysidacea* $8._8$, *Isopoda* $6._5$, *Gastropoda* $6._5$, *Pisces* $4._5$, *Polychæta* $4._2$, *Appendiculariæ* $3._8$, *Cirripedia* $3._5$, *Chætognatha* $3._1$, *Cumacea* $1._1$, *Ostracoda* $0._5$, *Lamellibranchiata* $0._3$ and *Bryozoa* $0._{02}$ %. Copepods were thus by far the most frequently occurring organisms, being found in $74._4$ % of the fish. Then came cladocerans, in $17._8$ % and fish eggs, amphipods and decapod larvæ in 11—13 % of the herring examined. Mysids, isopods and gastropods showed between 5 and 10 %, all other groups appeared only in less than 5 % of the fish. In a purely quantitative respect also, we found copepods in far greater numbers than all the other food organisms together, and there can hardly be any doubt that copepods as a whole are the most important organisms in the food of the herring in the inner Danish waters. They predominated in the food more particularly in spring, and to some extent also in winter; other organisms such as cladocerans, amphipods, mysids etc. were relatively more important as herring food in summer and autumn.

We will now, for purposes of comparison, briefly note the principal results arrived at regarding the food of the herring in other waters, going through the most important works on the subject, and mentioning the organisms found to occur most frequently in the stomach contents of the herring. The data are arranged as far as possible in order for the different waters.

The Baltic. Various writers note copepods and mysids as the principal food organisms for the herring of the Baltic and Gulf of Bothnia. (Münter 1863, p. 312; Møbius 1878, pp. 173—174; Lenz 1884, p. 174; Møbius & Heincke 1884, p. 264; Hensen 1893, p. 107; Schneider 1908, p. 80; Levander 1909, pp. 35—37; Otterstrøm 1910, p. 3; Hessle 1925, pp. 27, 36 and 39—42).

Skagerrak. Ljungman (1879, p. 271) and Trybom (1882 a, p. 289) mention especially copepods as food for the herring of the Skagerrak. Ehrenbaum & Peters (1922, p. 303) examining trawl-caught herring, likewise found mainly copepods; Lissner (1925, p. 202), Ehrenbaum (1925, p. 178) and E. M. Poulsen (1926, p. 287) note particularly *Meganyctiphanes norvegica* as an important item in the food of the herring in the Skagerrak.

The North Sea. A number of writers have made investigations as to the food of the herring in the North Sea, and if the results are rather dissimilar, this is doubtless due primarily to the difference in the nature of the areas investigated, but also to the difference of season, which seems to count for

much in the composition of the food. Sim (1883, p. 41) mentions firstly young specimens of the herring and sprat, and further, schizopods, copepods and amphipods. Pearcey (1885, p. 395) working in summer on herring from the Shetlands, found especially young stages of fish (*Ammodytes*, *Motella* etc.) and, in smaller numbers, copepods, crab larvæ etc. Off the east coast of Scotland, amphipods and schizopods were the leading forms in winter, and copepods in summer (Brook 1886, p. 49; Brook & Calderwood 1886, p. 127; Th. Scott 1888, p. 228). This last-named writer later (1902, pp. 529—532 and 1907, pp. 267—269) gives the following as specially important food organisms for the herring off the Scottish coasts: 1) post-larval fishes, 2) amphipods, 3) copepods, 4) schizopods and 5) decapod larvæ. Todd (1907, p. 120) found in a small number of herring nothing but herring roe in the stomach; Meek & Storrow (1912, p. 54) note copepods as the most important food. Among later investigations may be noted the German researches dealing with the food of North Sea herring, in which notably copepods, pteropods, schizopods and amphipods were found in great numbers (Ehrenbaum & Peters 1922, p. 298; Lissner 1925, pp. 203—205). The most important work on the food of the herring in the North Sea however, is that of Hardy (1924), who shows (pp. 34—35) that the herring in the south-western part of the North Sea live mainly on *Ammodytes* during the spring, and in summer more especially on copepods and amphipods, with schizopods, *Sagitta* etc. in lesser degree.

West Coast of Scotland. Stomach analyses of herring from the west coast of Scotland showed, according to investigations by Brook & Calderwood (1886, p. 128) copepods predominating in summer and autumn, and schizopods in winter. Th. Scott (1888, p. 228) on the other hand, found that in these waters, schizopods were, also in summer, the most important item in the food of the herring.

Irish Sea. A. Scott (1917, p. 9; 1918, pp. 5—6 and 1924, pp. 31—35) found copepods particularly important as food, with young stages of fish and *Meganyctiphanes* as minor items; Watkin, on the other hand (1925, p. 27) found mostly sprats in the stomach contents of herring from the Irish Sea.

West coast of Ireland. According to extant literature, the principal items in the food of the herring in western Irish waters are copepods, schizopods and amphipods (Farran 1903, p. 121; Holt & Tattersall 1905, pp. 136—137; Tattersall 1907, p. 5).

English Channel. Dunn (1894, p. 4) states that the food of the herring in spring and autumn consists mainly of copepods, amphipods, euphausiids, young stages of fish and spores of seaweed; Lebour (1924 b, pp. 403—404) gives euphausiids and copepods as by far the most important items in the food of the Channel herring.

Coasts of Norway. Copepods are generally noted as the principal food organisms, but in addition, pteropods (*Limacina*), cladocerans and schizopods are of considerable importance (Boeck 1866, pp. 158—162; Sars 1879, pp. 122—123; Collett 1905, pp. 25—29 and Nordgaard 1907, pp. 3—15). Buch (1883, pp. 13—14 and 1886, p. 70) found herring roe in great quantities in the stomachs of the spring-spawning herring.

Iceland. According to Ove Paulsen (1906, p. 13) the food of the herring off the north coast of Iceland consists chiefly of copepods (especially *Calanus finmarchicus*) together with crab larvæ, *Ammodytes* etc. Investigations as to the food of the herring in these waters undertaken by the present writer in the summer of 1926 and 1927 confirmed in the main these results. (See also Sæmundsson 1926, p. 404.)

East Coast of North America. On the Atlantic shores of North America, the herring live mainly on euphausiids and copepods (Moore 1898, pp. 401—403; Weber & Wilson 1920, p. 841). This is further confirmed by the most recent investigations on the food of the herring in the Gulf of Maine. Euphausiids are noted as the principal item, but when these are not present in sufficient quantity, the herring turn more especially to the copepods for their food (Bigelow & Welsh 1925, p. 103; Bigelow 1926, p. 102).

Generally speaking then, the results are as follows: In the Baltic and the Gulf of Bothnia, copepods and mysids are the most important organisms; in the Belt Sea and the Kattegat mainly copepods, with

cladocerans, fish eggs, amphipods, mysids etc. as minor items. In the Skagerrak the food consists mainly of copepods together with euphausiids. In the North Sea, the position is rather complicated, the herring feeding on different organisms in the different parts and at different seasons. It seems clear however, that they feed chiefly on fishes (especially *Ammodytes*) in the spring, whereas in summer and autumn their food consists rather of copepods, schizopods, amphipods and other crustacea, with *Sagitta*, pteropods etc. Along the west coast of Scotland and Ireland, in the Irish Sea and in the English Channel, the food is mainly composed of copepods and euphausiids. Off the coasts of Norway, copepods are of very great importance as herring food, but other organisms such as pteropods, cladocerans, schizopods and herring roe often serve as items in the diet. In the waters round Iceland, the herring feed mainly on copepods, crab larvæ and young *Ammodytes*, while off the Atlantic coasts of North America, euphausiids and copepods are by far the most important items in the food of the herring.

VI. Summary of Principal Results.

1. Relative number of herring containing food. A few larval stages of herring (yolk sac still present) taken in spring are found to contain food. The youngest stages of post-larval herring likewise show small quantities of food, but from a length of about 20 mm. upwards, food is found in at least 50 % of the specimens examined. Feeding increases as the post-larval stages grow up, and on entering the metamorphosis stage (length about 38—40 mm.) they are as a rule all found to contain food. In 95.5 % of the young herring examined (length 6—about 17 cm.) food is found, and these fish seem to feed largely at all seasons. Among the adult herring (about 17—30 cm.) food is found on an average in 57.2 %, and no special feeding season is noted among these fish, as is the case, for instance, with the herring of the south-western North Sea (Hardy 1924, p. 15).

2. Food in larval herring (yolk sac still present). Length 4—9 mm. The food in these cases consisted of an unidentifiable mass of a faint greenish colour.

3. Food of post-larval herring. (yolk sac resorbed.) Length 5—about 36 mm. The youngest stages live mainly on phytoplankton, gradually changing over to animal food. First come nauplii, copepod eggs and young copepods, later adult copepods, cladocerans etc. Among the adolescent stages of post-larval herring, copepods are by far the most important item of food.

4. Food of metamorphosis stages (scale formation commenced). Length about 38—50 mm. The food at this stage is rather varied, but copepods are by far the most important item. In addition, cladocerans and larval stages of cirripedes, polychætes and lamellibranchs appear fairly often in the food, copepod eggs and nauplii being found in smaller numbers.

5. Food of young herring. Length 6—about 17 cm. Copepods are numerically predominant, but in summer and autumn, cladocerans are also of considerable importance in the food. In some places, gastropod larvæ and decapod larvæ have been found in considerable numbers in the autumn, and polychætes, chætognaths and appendicularians are likewise noted as important food items. In the North Sea (Graadyb) the young herring in winter live mainly on copepods, but also to a large extent on mysids, amphipods and cumacea.

6. Food of adult herring. Length about 17—30 cm. The composition of the food varies greatly, crustacean items however, being far the commonest. Of all herring containing food, crustacea are found on an average in 93 %, and other organisms in 32 %. The principal crustacea are copepods, cladocerans, mysids, amphipods and isopods; of less frequent occurrence are cumacea, decapod larvæ and cirripede larvæ; ostracods have also been found, but are quite exceptional. Among non-crustaceous food may be specially noted fish eggs, polychætes and larval gastropods, but fishes, chætognaths and appendicularians are also fairly common. Lamellibranch larvæ and bryozoa larvæ are only found in very small numbers.

7. Composition of the food in the different waters. The four localities where the most regular investigations have been made as to the food of adult herring, viz. Rudkøbing, The Sound, Samsø and Frederikshavn, show considerable differences in the composition of the food. Among the cladocerans and copepods for instance, some genera appear in the food only or mainly among the herring of the Sound; mysids, isopods and cumacea seem to have their chief centre of importance at Rudkøbing; polychætes are fairly common in the food of the herring from Rudkøbing, Samsø and Frederikshavn, but are never observed in the stomach contents of herring from the Sound; larval gastropods serve as food for the herring chiefly in the Samsø and Frederikshavn waters; fish eggs especially at Rudkøbing, Samsø and in the Sound.

8. Composition of the food at different seasons. Roughly speaking, we find the following variations in the composition of the food of adult herring at the different seasons: In winter, and especially in spring, the food consists predominantly of copepods, the numbers of which, however, decrease as a rule as summer advances, while in autumn, only small quantities are found in the food. Various other organisms again, appear in greatest numbers in summer and autumn; we note, for instance, maximal occurrence of cladocerans and polychætes in May—August; decapod larvæ in July—September; mysids, amphipods, isopods and fishes in July—December; cumacea, larval gastropods, chætognaths and appendicularians in August—November. Fish eggs are found in most months of the year, but the greatest numbers in spring and autumn (herring eggs).

9. Feeding in relation to the degree of maturity. Herring feed as a rule only to a slight extent immediately before and during spawning; full and spawning herring from Rudkøbing and Samsø however, have at times been found to contain considerable amounts of food. The mature spring-spawning herring seem to feed far more often than the mature autumn-spawning fish. Among mature autumn-spawning herring from the north-eastern Kattegat (Groves Flak) very few are found to contain food, and the quantity was in all cases very small.

10. Food of young herring compared with that of adults. The relative number of young herring containing food is always in excess of that for adults, and the average number of organisms per young herring as a rule far greater than that for adults. This applies especially to the copepods, but cladocerans, cirripede larvæ, gastropod larvæ and appendicularians seem also to be more sought after by young herring than by the adults. Fish and fish eggs, on the other hand, are on the whole found in greater numbers among the adult herring than among the young ones. Larval gastropods are found in great numbers in young herring from Frederikshavn in autumn, but in adult herring only among the smallest sizes.

11. Feeding at different times of the day and night. Some experiments as to the feeding of young herring from Graadyb during the winter half year, show that the young herring feed mainly during the day, little or no feeding taking place at night.

12. Food of the herring in relation to composition of the plankton. A comparison between the occurrence of the different organisms in the food of the herring and in the plankton samples taken, shows that the herring do not feed indiscriminately on the plankton as a whole, but select certain organisms in preference to others. Coelenterates and echinoderm larvæ for instance, are never found in the food, and phytoplankton (diatoms) only exceptionally to any extent in adult fish. Various organisms occasionally numerous in the plankton, as for instance, bryozoa larvæ, lamellibranch larvæ, chætognaths and appendicularians appear as a rule but sparsely in the food of the adult herring. The same applies to the smallest forms of copepods. A great part of the organisms which serve as food for the herring would only be taken in small numbers by the plankton nets employed, and comparison is therefore only possible in the case of certain forms. This applies especially to copepods and cladocerans, various species of which show nice agreement between the occurrence in the herring food and in the plankton samples.

TABLES OF STOMACH ANALYSES

THE TABLES BELOW GIVE THE RESULTS OF STOMACH ANALYSES OF SOME FEW SAMPLES OF HERRING FROM DANISH WATERS. ONLY THOSE HERRING WHICH WERE FOUND WITH DEFINITE STOMACH CONTENTS IN THE RESPECTIVE SAMPLES ARE INCLUDED IN THE TABLES.

Table I. Rudkøbing. April 14, 1925.

Herring No.	3001	3002	3004	3005	3006	3008	3009	3010	3011	3012	3013	3014	3015	3016	3017	3018
Podon sp.	30	..	..	..	..	..	..	..	..	..	..	1	10	..	..	..
Calanus finmarchicus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pseudocal. + Paracalanus	400	1	1	4	110	2	850	1	56	2	2250	4	1120	2	76	3
Centropages hamatus	80	..	..	..	160	1	180	..	24	1	1120	1	250	1	195	..
Temora longicornis	190	..	..	2	325	2	275	1	190	8	720	3	340	..	148	2
Acartia sp.	40	1	..	2	..	..	12	..	4	..	..	..	5	..	..	..
Oithona similis	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..
Harpacticidæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Copepoda indet.	50	5	..	5	75	5	90	..	30	20	410	..	100	..	25	10
Cirripedia	..	..	..	..	..	..	2	..	1	..	8	..	..	..	..	..
Gastrosaccus spinifer	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Macromysis inermis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— flexuosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— neglecta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Schistomysis spiritus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— ornata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mysid. indet.	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Decapoda	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Idothea sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bathyporeia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Apherusa bispinosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calliopius Rathkei	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gammarellus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gammarus locusta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ischyrocerus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Corophium sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphip. indet.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polychæta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gastropoda	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pisces	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table II. Rudkøbing. May 14, 1924.

Herring No.	1675	1676	1677	1678	1679	1680	1681	1682	1683	1684	1685	1686	1687	1688
Podon sp.	..	..	..	..	..	..	1	..	..	2	..	1	..	1
Calanus finmarchicus	..	2	..	..	..	..	..	1	..	..	..	4	..	..
Pseudocal. + Paracalanus	1	320	110	120	26	145	210	1	1	345	2	710	125	200
Centropages hamatus	..	24	8	8	2	6	2	..	..	4	..	3	1	4
Temora longicornis	..	16	10	22	5	12	14	..	..	16	1	45	18	15
Acartia sp.	..	28	55	12	4	10	28	..	..	42	..	20	..	12
Oithona similis	..	..	..	..	..	..	..	..	..	1	..	..	..	..
Harpacticidæ	..	1	..	..	..	1	1	..	..	..	..	..	..	1
Copepoda indet.	..	40	20	15	..	35	25	..	..	15	..	50	20	25
Cirripedia	..	1	..	..	..	..	..	..	..	..	..	1	..	..
Gastrosaccus spinifer	..	..	..	..	..	..	..	..	..	..	..	1	..	..
Macromysis inermis	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— flexuosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— neglecta	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Schistomysis spiritus	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— ornata	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mysid. indet.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Decapoda	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Idothea sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bathyporeia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Apherusa bispinosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calliopius Rathkei	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gammarellus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gammarus locusta	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ischyrocerus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Corophium sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphip. indet.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polychæta	..	..	..	..	..	..	..	..	..	..	..	15	..	..
Gastropoda	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pisces	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table III. Rudkøbing. November 21, 1923.

Herring No.	1472	1473	1474	1476	1477	1479	1480	1481	1482	1483	1485	1487	1488
Podon sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Calanus finmarchicus	..	..	..	..	..	..	..	..	..	..	..	..	..
Pseudocal. + Paracalanus	..	..	..	..	..	..	..	..	..	..	..	..	..
Centropages hamatus	..	..	..	..	..	..	..	..	..	..	..	..	..
Temora longicornis	..	3	..	7	3	..	..	..	..	..	1	..	..
Acartia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Oithona similis	..	..	..	..	..	..	..	..	..	..	..	..	..
Harpacticidæ	..	..	..	..	1	..	..	..	..	..	..	..	..
Copepoda indet.	..	..	..	..	..	..	..	..	..	..	..	..	..
Cirripedia	..	..	..	..	..	..	..	..	..	..	..	..	..
Gastrosaccus spinifer	..	2	..	..	..	..	..	..	..	..	..	..	..
Macromysis inermis	..	..	..	..	..	..	8	..	..	..	3	..	..
— flexuosa	..	2	..	..	..	..	..	..	..	1	..	2	..
— neglecta	..	..	..	..	..	..	..	..	..	..	1	..	..
Schistomysis spiritus	..	2	1	48	..	..	1	..	..	..	..	..	..
— ornata	..	..	..	..	..	..	..	..	..	..	1	1	..
Mysid. indet.	..	18	..	..	1	..	6	..	..	14	10	8	..
Decapoda	..	..	..	..	..	..	..	..	..	..	..	..	..
Idothea sp.	..	2	..	..	..	1	..	..	..	..	1	3	..
Bathyporeia sp.	..	..	..	2	..	..	..	..	..	..	..	..	..
Apherusa bispinosa	..	..	..	..	..	..	8	..	..	..	14	35	..
Calliopius Rathkei	..	..	..	1	..	..	..	..	..	..	..	..	..
Gammarellus sp.	..	..	..	1	..	..	..	..	..	..	..	..	..
Gammarus locusta	3	290	..	8	..	..	18	2	3	9	34	22	3
Ischyrocerus sp.	..	..	..	..	..	..	2	..	1	..	..	..	..
Corophium sp.	..	4	..	..	..	..	..	..	..	..	3	3	..
Amphip. indet.	2	9	1	3	..	..	9	..	4	25	21	..	..
Polychæta	..	..	..	..	..	..	..	..	..	..	1	..	..
Gastropoda	1	..	..	..	..	..	..	..	..	..	..	..	..
Pisces	..	..	..	..	..	..	..	..	..	..	..	..	..

Table IV. Rudkøbing. December 21, 1923.

Herring No.	1497	1498	1499	1500	1501	1502	1503	1504	1505	1506	1507	1508	1509	1510	1511	1512	1513	1514	1515	1516
Podon sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calanus finmarchicus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pseudocal. + Paracalanus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Centropages hamatus	12	..	3	..	..	..	..	..	..	..	2	..	12	5	..	..	..	..	..	..
Temora longicornis	230	8	55	165	110	..	15	3	..	..	5	..	75	12	11	..	..	..	..	..
Acartia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
Oithona similis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Harpacticidæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Copepoda indet.	50	5	25	30	75	..	..	..	..	..	..	..	20	..	..	..	..	..	..	..
Cirripedia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Gastrosaccus spinifer	4	16	42	..	..	..	3	4	..	12	..	..	..	1	8	..	5	4	..	1
Macromysis inermis	2	1	..	..	..	..	..	..	..	120	5	3	3	..	5	..	..	..	..	19
— flexuosa	..	..	..	..	..	..	1	..	75	..	..	..	..	..	..	..	..	..	..	..
— neglecta	..	..	..	..	..	..	..	..	..	16	..	..	..	..	2	19	1	..	..	12
Schistomysis spiritus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— ornata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mysid. indet.	1	..	8	..	..	26	2	2	3	8	1	2	2	4	5	3	7	..	..	6
Decapoda	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Idothea sp.	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bathyporeia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Apherusa bispinosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calliopius Rathkei	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gammarellus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gammarus locusta	4	2	2	..	1	..	1	..	1	11	2	..	..	2	2	..	10	..	2	3
Ischyrocerus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Corophium sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphip. indet.	..	2	..	..	..	..	1	2	..	..	..	..	..	..	..	..	4	..	2	..
Polychæta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gastropoda	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pisces	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..

Tables V—VI. The Sound, Svanemølle Bugt.

V. September 18, 1925. VI. September 25, 1925.

Herring No.	3228	3231	3232	3234	3235	3236	3237	3238	3239	3240	3241	3242	3243	3244	3245	3247	3250	3251	3252	3253	3254	3255	3256	3257	3258	3259	3260	3261	3263	3264	3265	3266	3268	3270	3271	3272	3273	3274	3275	3276
Bosmina maritima	.	2	4	.	2	950	3	1	22	8	1	2	3	.	.	.	.	1	.	15	.	.	27	70	4	.	2	1	3	45	.	25	3	.	2	.	2	1	3	1
Evadne sp.	.	7	2	5	.	550	4	3	9	6	1	2	6	.	.	2	1	3	1	3	1	1	.	.	3	1	8	2	.	.	1	.	1	.	1	.	1	1	1	
Podon sp.	.	.	1	.	.	10	1	.	6	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Pseudocal. + Paracalanus	.	1	.	.	2	4	.	.	2	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	
Centropages hamatus	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
Temora longicornis	.	2	.	2	1	260	.	1	6	2	.	.	2	.	1	.	.	.	.	5	.	1	9	20	.	.	.	.	.	2	.	2	.	1	.	.	.	.	.	
Eurytemora hirundo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
Acartia sp.	.	.	.	.	.	.	.	.	1	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	2	.	.	2	.	.	2	.	.	.	.	.	
Copepoda indet.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	10	15	.	.	.	.	.	20	.	10	10	.	15	.	.	.	.	.	
Gastrosaccus spinifer	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Macromysis flexuosa	4	.	.	.	1	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Idothea sp.	11	.	3	.	.	.	.	.	.	.	.	.	.	6	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	
Gammarus locusta	8	.	1	1	.	.	.	.	.	.	.	.	.	2	2	.	1	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	.	.	.	.	.	
Corophium volutator	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Gastropoda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	
Pisces	.	1	.	1	.	.	.	2	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	
Pisces ova	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	

Table VII. The Sound, off Snekkersten. November 6, 1925.

Herring No.	3778	3779	3780	3782	3783	3784	3786	3787	3788	3789	3790	3791	3792	3793	3794	3795	3796	3797	3798	3799	3800	3801	3802	3803	3804	3805	3806	3807	3808	3809
Podon sp.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Pseudocal. + Paracalanus	.	3	2	2	2	6	1	28	4	8	33	10	5	34	14	28	12	27	5	11	54	33	32	6	26	1	35	1	22	35
Centropages typicus	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
— hamatus	.	1	1	.	1	.	.	.	.	.	.	1	2	1	1	2	.	1	2	.	7	.	.	.	.	1	.	1	.	2
Temora longicornis	3	8	.	.	3	2	1	7	2	3	5	5	4	11	11	4	2	13	1	3	25	5	11	.	5	.	8	.	9	8
Eurytemora hirundo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Labidocera Wollastoni	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acartia sp.	1	1	3	.	2	11	.	11	5	.	22	1	.	10	4	15	.	3	.	.	4	2	.	2	.	.	.	1	.	12
Harpacticidæ	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.
Copepoda indet.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirripedia	.	5	.	.	1	1	.	1	1	2	.	.	2	2	3	.	1	2	.	.	8	7	.	1	.	.	2	.	1	1
Macromysis flexuosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mysid. indet.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Idothea sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gammarus locusta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gastropoda	.	17	.	1	2	5	5	8	2	1	11	3	5	4	20	.	.	2	1	.	32	6	12	1	5	.	8	2	2	4
Sagitta sp.	3	.	1	.	.	.	2	4	.	.	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Oikopleura sp.	3	.	16	.	.	2	.	16	6	.	29	.	.	15	29	25	.	.	1	.	10	1	12	1	2	1	2	.	1	2
Pisces	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table VIII. Køge Bugt. November 21, 1925.

Herring No.	3810	3811	3812	3813	3814	3815	3816	3818	3820	3821	3822	3823	3824	3825	3826	3827	3828	3829	3830	3831	3832	3833	3834	3835	3836	3837	3838	3839
Podon sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Pseudocal. + Paracalanus	5	1	2	.	12	8	.	2	18	4	.	1	.	3	.	.	12	.	.	.	1	3	2	.	.	.	.	3
Centropages typicus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— hamatus	4	.	.	1	3	1	.	.	4	.	.	1	.	.	.	1	2	.	.	2	2	2	1	2	.	.	1	.
Temora longicornis	65	3	180	110	125	50	.	65	70	80	45	120	48	50	155	130	170	55	15	84	35	80	150	210	54	32	26	145
Eurytemora hirundo	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Labidocera Wollastoni	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acartia sp.	24	4	85	27	45	55	.	15	32	20	22	25	28	22	25	45	90	5	9	24	30	55	45	95	12	14	21	175
Harpacticidæ	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Copepoda indet.	.	.	20	20	15	.	.	10	10	.	30	30	.	.	.	20	.	.	.	20	25	.	30	.	10	.	20	50
Cirripedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Macromysis flexuosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Mysid. indet.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.
Idothea sp.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Gammarus locusta	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Gastropoda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sagitta sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oikopleura sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pisces	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table IX. Samsø. April 28, 1924.

Herring No.	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Polychæta	..	2	..	..	..	..	..	..	..	2	3	..	..	..	..	..
Podon sp.	..	..	..	2	..	..	..	..	..	..	..	1	..	..	..	..
Calanus finmarchicus	..	..	2	..	..	1	..	..	..	2	4	..	..	..	..	..
Pseudocal. + Paracalanus	510	1250	148	550	3	4250	4	2250	5	18	1100	5	1270	1520	12	1220
Centropages hamatus	15	120	16	50	..	330	..	120	2	1	45	..	50	50	1	35
Temora longicornis	126	144	24	90	..	90	..	95	3	2	115	..	160	80	1	130
Acartia sp.	..	..	..	..	..	5	..	..	..	..	..	2	10	20	..	5
Oithona similis	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..
Harpacticidæ	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..
Copepoda indet.	80	110	20	40	..	50	..	50	..	10	50	..	150	60	..	105
Cirripedia	..	1	..	..	..	2	..	..	..	..	..	..	3	..	..	4
Mysidacea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Decapoda	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Idothea sp.	..	1	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Gammarus locusta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sagitta sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oikopleura sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pisces	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pisces ova	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table X. Samsø. September 30, 1924.

Herring No.	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140
Polychæta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Podon sp.	..	6	3	..	..	..	6	6	9	25	1	5	3	9	60	50	16	2	..	25
Calanus finmarchicus	..	..	1	..	..	..	1	..	2	..	..	..	..	..	1	5	4	..	1	4
Pseudocal. + Paracalanus	1	10	..	..	1	..	195	7	45	35	2	180	2	3	2420	800	420	10	12	2180
Centropages hamatus	1	..	..	..	..	..	..	..	5	..	..	5	..	1	..	..	..	1	..	..
Temora longicornis	4	..	..	..	..	..	27	..	2	2	4	30	1	2	90	15	8	1	1	35
Acartia sp.	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Oithona similis	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
Harpacticidæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Copepoda indet.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	50	..	20	..	..	..
Cirripedia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mysidacea	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Decapoda	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	2	..	1
Idothea sp.	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
Gammarus locusta	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Sagitta sp.	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oikopleura sp.	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	35	..	..	..	30
Pisces	..	6	165	100	..	..	9	..	1625	2800	8	850	280	..	..	175	20	8	45	1050
Pisces ova	..	1	..	..	360	3410	..	7	3	5	20	2	..	190	..	..	..	..	3	210

Tables XI—XIII. Frederikshavn. Adult herring (length 17—24 cm.).

XI. October 12, 1923. XII. Oct. 21, 1923. XIII. October 30, 1923.

Herring No.	914	916	917	918	919	920	922	923	927	928	932	934	941	943	950	951	960	971	975	998	999	1004	1005	1006	1008	1009	1014	1016	1017	1018	1019	1020	1025	1028	1029	1030
Polychæta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Calanus finmarchicus	.	.	1	.	6	.	2	1	.	2	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudocal. + Paracalanus	.	.	.	.	4	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Centropages hamatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	1	.	.	1	.	.	.	1	.	.	.	.
Temora longicornis	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	.	1	.	.	2	.	.	2	.	.	.	.	.
Acartia sp.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Harpacticidæ	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	2	.	1	.	1	.	1	.
Corycæus anglicus	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	1	1	.	.	1
Copepoda indet.	.	.	5	.	2	.	.	2	.	.	5	.	.	.	.	.	10	.	.	.	.	.	1	.	1	.	.	2	.	.	.	.	.	.	.	.	1
Decapoda	4	1	1	1	2	.	1	.	.	4	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Idothea sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Amphipoda	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.
Gastropoda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	12	27	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.
Sagitta sp.	.	.	1	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oikopleura sp.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pisces	.	.	.	.	.	.	.	1	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pisces ova	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.

Tables XIV—XVI. Frederikshavn. Young herring (length 12—15 cm.).

XIV. Oct. 12, 1923. XV. October 21, 1923. XVI. Oct. 30, 1923.

Herring No.	935	936	937	938	939	956	958	959	961	962	963	964	965	966	967	968	969	970	972	973	974	978	979	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	1001	1002	1022	1031
Evadne sp.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Podon sp.	1	10	12	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calanus finmarchicus	17	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudocal. + Paracalanus	89	170	132	110	12	7	1	1	.	4	14	8	.	7	.	2	.	1	1	1	.	.	2	8	2	2	2	.	.	1	1	1	.	20	.	.	2	17	1	5	2	.	2	.
Centropages hamatus	12	11	2	.	.	2	.	3	.	1	1	10	.	1	.	.	.	.	.	.	.	.	1	6	4	1	1	.	.	1	.	.	1	4	.	1	.	4	1	.	1	.	7	.
Isias clavipes	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Temora longicornis	27	17	34	18	2	3	.	2	.	3	1	.	.	.	.	.	.	.	.	.	.	3	.	4	1	5	.	.	1	.	.	1	.	8	.	1	2	3	1	1	3	.	4	.
Labidocera Wollastoni	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Acartia sp.	22	69	18	8	1	1	.	.	.	.	7	3	.	1	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	7	.	1	.	5	.	.	.	.	1	.
Oithona sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Harpacticidæ	5	10	18	16	3	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	4	.	.	4	.	.	.	.	.	2	1
Corycæus anglicus	23	18	38	26	9	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
Copepoda indet.	50	95	75	150	35	5	.	.	1	3	.	10	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.	.	.	.	2	.	.	.	.	.	.	8	.	.	.	.	.	.
Cirripedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.
Decapoda	4	6	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Idothea sp.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amphipoda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	8	.	.
Gastropoda	.	17	8	.	4	200	.	40	50	60	2	125	.	10	150	5	.	.	5	.	30	45	2	350	85	320	3	4	3	18	20	140	85	870	.	55	1340	45	95	3	95	.	225	12
Lamellibranchiata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Oikopleura sp.	.	12	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	5	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Pisces	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Zostera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.

Table XVII. The North Sea. St. 2836. September 27, 1922.

Herring No.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Calanus finmarchicus ...	60	85	120	66	108	146	93	145	280	90	138	190	140	135	14	210	250	53	14	130
Pseudocal. + Paracalanus	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Centropages typicus	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
— hamatus ...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	1	..	..	..
Isias clavipes	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
Temora longicornis	3	1	2	3	5	2	1	4	18	1	1	1	1	6	1	30	24	6	2	220
Labidocera Wollastoni...	1	..	..	..	2	6	3	2	2	6	1	2	1	..	3	2	6	1	..	..
Parapontella brevicornis.	..	..	1	2	1	..	..	3	..	1	..	1	..	1	1	2	..	1	..	..
Harpacticidæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Mysidacea	..	..	..	..	..	..	1	..	..	..	..	..	..	1	..	..	..	..	..	..
Decapoda	20	53	47	47	60	38	40	30	48	51	68	51	32	25	30	68	54	11	2	5
Cumacea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Amphipoda	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..
Sagitta sp.	25	5	12	1	3	..	..	2	2	..	3	28	5	15	..	..	48	4	..	80
Oikopleura sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table XVIII. The North Sea. St. 2847. September 30, 1922.

Herring No.	24	25	27	29	30	31	32	33	34	35	37	38	39	40	41	42	43	44	46	47	48	49
Calanus finmarchicus ...	1	2	3	..	..	2	1	2	..	1	2	2	1	3	2	..	..	..	..	2	..	2
Pseudocal. + Paracalanus	2	5	..	2	..	2	..	5	..	..	..	5	1	..	1	1	2	..	..	1	3	1
Centropages typicus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— hamatus ...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Isias clavipes	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Temora longicornis	45	55	3	3	2	14	10	75	38	10	14	72	35	3	4	20	10	27	32	70	48	75
Labidocera Wollastoni...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Parapontella brevicornis.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Harpacticidæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mysidacea	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Decapoda	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cumacea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphipoda	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sagitta sp.	1	..	..	2	..	..	11	3	..	6	7	5	2	..	3	2	4	..	1	7	..	1
Oikopleura sp.	..	..	..	..	..	..	..	1	..	2	..	..	..	..	5	..	..	..	..	..	..	1

List of Literature.

Bigelow, Henry B. (1926). Plankton of the Offshore Waters of the Gulf of Maine. — Bull. Bur. Fisheries, Vol. XL, 1924, Pt. II, Document No. 968. Washington.

Bigelow, Henry B. and Welsh, W. W. (1925). Fishes of the Gulf of Maine. — *Ibid.*, Vol. XL, 1924, Pt. I, Document No. 965.

Björck, Wilhelm (1915). Biologisk-Faunistiska Undersökningar av Öresund. II. Crustacea Malacostraca och Pantopoda. — Lunds Univ. Årsskrift, N. F., Afd. 2, Bd. 11, Nr. 7. Lund.

Blegvad, H. (1917). On the Food of Fish in the Danish Waters within The Skaw. — Rep. Danish Biol. Station, XXIV, 1916. Copenhagen.

— (1922). On the Biology of some Danish Gammarids and Mysids (*Gammarus locusta, Mysis flexuosa, Mysis neglecta, Mysis inermis*). — *Ibid.*, XXVIII, 1922.

Boeck, Axel (1866). Om Sildeaat. — Tidsskrift for Fiskeri, I Aarg. Kjøbenhavn.

— (1871). Om Silden og Sildefiskerierne navnlig om det norske Vaarsildfiske I. — Indberet. til den Kgl. Norske Regierings Depart. for det Indre om foret. prakt.-vidensk. Undersøgelser. Christiania.

Brook, George (1886). Report on the Herring Fishery of Loch Fyne and the adjacent Districts during 1885. — Fourth Annual Report, Fishery Board for Scotland, 1885. Edinburgh.

Brook, G. and Calderwood, W. L. (1886). Report on the Food of the Herring. — *Ibid.*, 1885.

Buch, S. A. (1883). Indberetning til Departementet for det Indre om de i 1883 udførte praktisk-videnskabelige Undersøgelser over Vaarsildfisket. — Christiania.

— (1884). Indberetning til Departementet for det Indre om de i 1884 udførte praktisk-videnskabelige Undersøgelser over Vaarsildfisket.

— (1886). Indberetning til Departementet for det Indre om de i 1885 udførte praktisk-videnskabelige Undersøgelser over Vaarsildfisket.

Bullen, G. E. (1912). Some Notes upon the Feeding Habits of Mackerel and certain Clupeoids in the English Channel. — Journ. Mar. Biol. Assoc., Vol. IX, No. 3. Plymouth.

Collett, R. (1905). Meddelelser om Norges Fiske i Aarene 1884—1901. (3die Hoved-Supplement til »Norges Fiske«) III. — Christiania Vid. Selsk. Forh. 1905, No. 7. Christiania.

Dunn, Mathias (1894). The Migrations and other Habits of the Herring on the Coasts of Devon and Cornwall.

Ehrenbaum, E. (1912). Mitteilungen über die Lebensverhältnisse unserer Fische. 10. Clupea harengus, L. Hering. Die Lebensweise des Herings. — Der Fischerbote, Jahrg. IV, 1912. Nr. 7.

— (1925). Untersuchungen über den Trawlhering. — Berichte Deutsch. wiss. Komm. f. Meeresforsch., N. F., Bd. I (1919—23). Berlin.

Ehrenbaum, E. and Peters, N. (1922). Ueber den Trawlhering. — Der Fischerbote, Jahrg. XIV, 1922, Nr. 11.

Farran, G. P. (1903). Record of the Copepoda taken on the Mackerel Fishing Grounds off Cleggan, Co. Galway, in 1901. — Ann. Rep. Fish., Ireland, 1901, Pt. II, App. VIII. Dublin.

Fischer, E. (1907). Fischereiuntersuchungen. (Henking: Eine Fahrt des »Poseidon« in das Fanggebiet der Grossen Heringsfischerei, September 1905). — Mitt. Deutsch. Seefischerei-Vereins 1907, Nr. 8—9. Berlin.

Hansen, H. J. (1910). Revideret Fortegnelse over Danmarks marine Arter af Isopoda, Tanaidacea, Cumacea, Mysidacea og Euphausiacea. — Vid. Medd. Naturh. Forening for 1909. Kjøbenhavn.

Hardy, A. C. (1924). The Herring in Relation to its Animate Environment. Part I. The Food and Feeding Habits of the Herring with Special Reference to the East Coast of England. — Min. Agric. and Fisheries, Fishery Investigations, Series II, Vol. VII, No. 3. 1924. London.

Heincke, Friedrich (1878). Die Varietäten des Herings. — Jahresber. Comm. wiss. Unters. der deutsch. Meere für die Jahre 1874, 1875, 1876. Jahrg. IV—VI. Berlin.

— (1898). Naturgeschichte des Herings. Teil I. Die Lokalformen und die Wanderungen des Herings in den europäischen Meeren. — Abhandl. Deutsch. Seefischerei-Vereins, Bd. II. Berlin.

Hensen, V. (1893). Das Plankton der östlichen Ostsee und des Stettiner Haffs. — Sechst. Ber. Komm. wiss. Unters. der deutsch. Meere 1887—91. Jahrg. XVII—XXI. Berlin.

Hessle, Chr. (1925). The Herrings along the Baltic Coast of Sweden. — Publ. de Circonstance, No. 89. Conseil Perm. Intern. pour l'Expl. de la Mer. Copenhague.

Hodgson, William C. (1925). Investigations into the Age, Length and Maturity of the Herring of the Southern North Sea. Part I. Some Observations on the Scales and Growth of the English Herring. — Min. Agric. and Fisheries, Fishery Investigations, Series II, Vol. VII, No. 8. 1924. London.

Holt, E. W. L. and Tattersall, W. M. (1905). Schizopodous Crustacea from the North-East Atlantic Slope. — Ann. Rep. Fish., Ireland, 1902—03, Pt. II, App. IV. Dublin.

Huxley, T. H. (1881). The Herring. — Nature, Vol. XXIII, 1880—81.

Jensen, Søren; Johansen A. C. and Levinsen, J. Chr. L. (1903). De danske Farvandes Plankton i Aarene 1898—1901. II. Crustacea. — Kgl. Danske Vid. Selsk. Skrifter, 6. Række, naturv. og math. Afd., XII, 3. Kjøbenhavn.

Johansen, A. C. (1923). Ueber die Winterheringe des Kattegats. — Wiss. Meeresuntersuch., N. F., Bd. XV., Abt. Helgoland (Festschrift für Fr. Heincke, Abh. Nr. 12). Oldenburg i. O.

— (1924). On the Summer- and Autumn-Spawning Herrings of the North Sea. — Medd. fra Komm. for Havundersøgelser, Ser. Fiskeri, Bd. VII, Nr. 5. København.

— (1927). On the Migrations of the Herring. — Journal du Conseil, Vol. II, No. 1. Conseil Perm. Intern. pour l'Expl. de la Mer. Copenhague.

Kyle, H. M. and Ehrenbaum, E. (1927). Teleostei Physostomi. I. Clupeiformes. — Die Tierwelt der Nord- und Ostsee, Teil XII, fs. Leipzig.

Lebour, Marie V. (1918). The Food of Post-Larval Fish. — Journ. Mar. Biol. Assoc., Vol. XI, No. 4. Plymouth.

— (1920). The Food of Young Fish. No. III. (1919). — *Ibid.*, Vol. XII, No. 2.

— (1921). The Food of Young Clupeoids. — *Ibid.*, Vol. XII, No. 3.

— (1924 a). The Food of Young Herring. — *Ibid.*, Vol. XIII, No. 2.

— (1924 b). The Euphausiidæ in the Neighbourhood of Plymouth and their Importance as Herring Food. — *Ibid.*, Vol. XIII, No. 2.

Lenz, Heinrich (1884). Die wirbellosen Thiere der Travemünder Bucht. II. — Viert. Ber. Comm. wiss. Unters. der deutsch. Meere 1877—81. Jahrg. VII—XI. Berlin.

Levander, K. M. (1909). Beobachtungen über die Nahrung und die Parasiten der Fische des Finnischen Meerbusens. — Finnländ. hydrogr.-biolog. Untersuchungen, No. 5. Helsingfors.

Lilljeborg, W. (1891). Sveriges och Norges Fauna. Fiskarne. III. — Upsala.

Lissner, Hellmuth (1925). Die Nahrungsaufnahme beim Hering. — Berichte Deutsch. wiss. Komm. f. Meeresforsch., N. F., Bd. I. (1919—23). Berlin.

Ljungman, A. V. (1879). Bidrag till kännedomen om sillens lefnadsförhållanden. — Nordisk Tidsskr. for Fiskeri, 5 Aarg. Kjøbenhavn.

McIntosh and Masterman. (1897). The Life-Histories of the British Marine Food-Fishes. — London.

Meek, A. and Storrow, B. (1912). Trawl-caught Herring landed at North Shields. — Dove Marine Laboratory, Cullercoats. Report for the year ending June 30th, 1912. N.S., I. Newcastle-upon-Tyne.

Mielck, W. (1925). Heringslarven, Eier und Larven anderer Fische und Nahrung der Larven in der westlichen Nordsee im Oktober 1922. — Berichte Deutsch. wiss. Komm. f. Meeresforsch., N. F., Bd. I. (1919—23). Berlin.

Moore, H. F. (1898). Observations on the Herring and Herring Fisheries of the Northeast Coast, with special Reference to the Vicinity of Passamaquoddy Bay. — U. S. Com. of Fish and Fisheries, Part XXII. Commissioners Report 1896. Washington.

Möbius, K. (1873). Über die Nahrung der Heringe im Kieler Hafen. — Schrift. Naturwiss. Ver. für Schleswig-Holstein I., Heft 1. Kiel.

— (1878). Untersuchungen über die Nahrung der Heringe im Jahre 1875—76. — Jahresber. Comm. wiss. Unters. der deutsch. Meere für die Jahre 1874, 1875, 1876. Jahrg. IV—VI. Berlin.

Möbius, K. and Heincke, Fr. (1884). Die Fische der Ostsee. — Viert. Ber. Comm. wiss. Unters. deutsch. Meere 1877—81. Jahrg. VII—XI. Berlin.

Münter, J. (1863). Ueber den Hering der pommerschen Küsten und die an denselben sich anschliessenden Industriezweige. — Archiv für Naturgeschichte, 29 Jahrg., I. Berlin.

Nordgaard, O. (1907). Iagttagelser over Sildens Aate. — Det Kgl. Norske Vidensk. Selsk. Skrifter 1907, No. 2. Trondhjem.

Ogilvie, Helen S. (1927). Observations on the Food of Post-Larval Herring from the Scottish Coast. — Fishery Board for Scotland. Scientific Investigations 1927, No. 1. Edinburgh.

Otterstrøm, Andreas (1910). Beobachtungen ueber die senkrechten Wanderungen des Mysisbestandes in der Ostsee bei Bornholm in den Sommermonaten 1906 und 1907. — Medd. fra Komm. for Havundersøgelser, Ser. Plankton, Bd. I, Nr. 9. København.

Paulsen, Ove (1906). Studies on the Biology of Calanus finmarchicus in the Waters round Iceland. — *Ibid.*, Ser. Plankton, Bd. I, Nr. 4.

Pearcey, F. G. (1885). Investigations on the Movements and Food of the Herring, with Additions to the Marine Fauna of the Shetland Islands. — Proc. Royal Phys. Soc. of Edinburgh, 1884—85, Vol. VIII. Edinburgh.

Petersen, C. G. Joh. (1891). Fiskenes biologiske Forhold i Holbæk Fjord 1890—(91). — Beretn. fra Den danske biol. Station, I. 1890—(91). (Fiskeri-Beretn. for 1890—91). Kjøbenhavn.

Poulsen, Erik M. (1926). Om den store Lyskrebs (*Meganyctiphanes norvegica*) Betydning som Fiskeføde i Skagerak. — Dansk Fiskeritidende 1926, Nr. 24. København.

Sars, G. O. (1879). Indberetninger til Departementet for det Indre om de af ham i Aarene 1864—1878 anstillede Undersøgelser angaaende Saltvandsfiskerierne. — Christiania.

Savage, R. E. (1926). The Plankton of a Herring Ground. — Min. Agric. and Fisheries, Fishery Investigations, Series II, Vol. IX, No. 1. 1926. London.

Schneider, Guido (1908). Die Clupeiden der Ostsee. — Rapports et Procès-Verbaux, IX. Conseil Perm. Intern. pour l'Expl. de la Mer. Copenhague.

Scott, Andrew (1917). Summary of the Work at Piel. V. Food of Port Erin Herring. — Lancashire Sea-Fisheries Laboratory, Report for 1916. XXV. Liverpool.

— (1918). Report on the Work at Piel. III. Food of Port Erin Herring. — *Ibid.*, Rep. for 1917. XXVI.

— (1924). Food of the Irish Sea Herring in 1923. — *Ibid.*, Rep. for 1923. XXXII.

Scott, Thomas (1888). Notes on the Contents of the Stomachs of Herring and Haddocks. — Sixth Annual Report, Fishery Board for Scotland, 1887, III. Edinburgh.

— (1902). Observations on the Food of Fishes. — Twentieth Annual Report, Fishery Board for Scotland, 1901, III. Glasgow.

— (1907). Some Observations on the Food of the Herring. — Twenty-fifth Annual Report, Fishery Board for Scotland, 1906, III. Glasgow.

Sim, G. (1883). The Natural History of the Herring. — International Fisheries Exhibition, Edinburgh, 1882. Edinburgh and London.

Stephensen, K. (1910). Storkrebs I. Skjoldkrebs. — »Danmarks Fauna«, Nr. 9. København.

Strøm, Hans (1784). Om Silde- eller Rød-Aat. — Norske Vidensk. Selsk. Skrifter, N. S., I, B. Kjøbenhavn.

Sæmundsson, Bjarni (1926). Fiskarnir (Pisces Islandiæ). — Íslensk Dýr I. Reykjavik.

Tattersall, W. M. (1907). Pelagic Amphipoda of the Irish Atlantic Slope. The Marine Fauna of the Coast of Ireland, Part VIII. — Fisheries, Ireland, Sci. Invest., 1905, IV. Dublin.

Todd, R. A. (1907). Second Report on the Food of Fishes (North Sea 1904—1905). — Mar. Biol. Assoc. of the Unit. Kingdom, Intern. Fishery Investig., Second Report (Southern Area) 1904—05. Part I. London.

Trybom, Filip (1882 a). Iakttagelser vid sillfisket i Bohuslän vintrarne 1880—81 och 1881—82. — Nordisk Tidsskrift for Fiskeri, 7. Aarg. Kjøbenhavn.

— (1882 b). Iakttagelser om det lägre djurlifvet på de platser utanför Bohusläns kust, der sillfiske med drifgarn bedrefs vintern 1880—81. — Öfversigt af Kongl. Vet. Akad. Förhandl. 1881, No. 3. Stockholm.

— (1889). Sillundersökningar vid Sveriges Vestkust Hösten 1888. — Berättelse till kongl. Civildepartementet. Stockholm.

Watkin, E. Emrys (1925). Investigations on Cardigan Bay Herring. II. On Samples from Borth, Aberystwyth and Newquay, 1922. — Rep. on Marine & Fresh Water Investigations, Dep. of Zool., University College of Wales, Aberystwyth. N. S., I. London.

Weber, F. C. and Wilson, J. B. (1920). The Food of the Small Sea Herring and Ammonia and Amines as End Products of its Decomposition. — Journ. Americ. Chemic. Soc., Vol. 42, 1920.

Williamson, H. Chas. (1910). On the Herrings of the Clyde and other Districts. — Twenty-Seventh Annual Report, Fishery Board for Scotland, 1908, III. Glasgow.

Wright, W. von (1843). On the Herring and the Causes of its Scarcity on the Swedish Coasts. — Handl. rör. Sillfisket i bohuslänska skärgården. Stockholm.

Dansk Resumé.

P. Jespersen: Undersøgelser over Sildens Føde i danske Farvande.

Da Silden er en af de i økonomisk Henseende vigtigste Fisk i de nordeuropæiske Have, har det stor Interesse at faa undersøgt, hvad den lever af paa forskellige Udviklingstrin og i forskellige Farvande samt paa forskellige Aarstider for om muligt at komme til Klarhed over Aarsagerne til dens mere eller mindre talrige Forekomst i de forskellige Aar. Det foreliggende Arbejde tilsigter i første Række at fastslaa, hvilke Organismer der i særlig Grad tjener Silden som Næring i de danske Farvande inden for Skagen, idet der i Litteraturen kun findes enkelte og ganske summariske Oplysninger vedrørende dette Spørgsmaal; men desuden er der foretaget Undersøgelser over Fødeoptagelsen og Fødens Art i Forhold til Sildens forskellige Udviklingstrin og Modenhedsgrad, samt i Forhold til de forskellige Organismers Optræden i Planktonet. Endvidere er der foretaget nogle Forsøg for at faa konstateret, paa hvilke Tider af Døgnet Silden især søger sin Føde.

Grundlaget for Arbejdet er Analyser af Mave- og tildels Tarmindholdet hos 7316 Sild. De undersøgte Sild er efter deres forskellige Udviklingstrin inddelt i følgende 5 Grupper:

1. Larvale Stadier (Blommesæk til Stede)	Længde	4 mm.—	9 mm.
2. Postlarvale Stadier (Blommesæk resorberet)	—	5 mm.—	ca. 36 mm.
3. Metamorfose-Stadier (Skældannelse begyndt)	—	ca. 38 mm.—	50 mm.
4. Ungsild	—	6 cm. —	ca. 17 cm.
5. Voksne Sild	—	ca. 17 cm. —	30 cm.

Hos de tre førstnævnte Grupper er hele Fordøjelseskanalens Indhold undersøgt, medens der hos Ungsild og voksne Sild kun er foretaget Analyser af Maveindholdet. Af larvale, postlarvale og Metamorfose-Stadier er der ialt undersøgt 2827 Stkr., af Ungsild 2061 Stkr. og af voksne Sild 2428 Stkr. De Organismer, der er fundet i Sildeføden, er, saa vidt det har været muligt, bestemt og optalt. Optællingerne danner Grundlaget for Undersøgelser over de forskellige Organismers Forekomst i Føden.

Indsamlingen af larvale, postlarvale og Metamorfose-Stadier er foretaget fra Havundersøgelsesdamperen »Dana« i forskellige danske Farvande i Foraaret 1923 og i Efteraaret 1925.

De fleste af de undersøgte Ungsild stammer fra Graadyb, hvor de er indsamlet fra »Dana« i Vinterhalvaarene 1922—23, 1923—24, 1924—25 og 1925—26. Af Ungsild foreligger endvidere enkelte Prøver fra nogle Stationer langs Vestkysten af Jylland, fra Læsø Rende og fra Farvandet ved Rudkøbing og Frederikshavn.

Materialet af voksne Sild hidrører i overvejende Grad fra Bundgarn. Paa følgende Steder er der udtaget Prøver af Bundgarnssild:

Rudkøbing. Pæregaardsbugt paa Vestkysten af Langeland.
Sundet og Køge Bugt. Strækningen fra Snekkersten til den nordlige Del af Køge Bugt.
Samsø. Staalhøjshage, Besserrev og Nordbybugten paa Nordøstkysten af Samsø.
Frederikshavn. Umiddelbart Syd for Byen.

Paa de Tider af Aaret, hvor der paa de forskellige Steder er drevet Bundgarnsfiskeri efter Sild, er der, saa vidt muligt med ca. 10 Dages Mellemrum, indsamlet Prøver af Sild til Undersøgelse. Fra Sundet foreligger endvidere enkelte Prøver, taget med Drivgarn, og fra Groves Flak i Kattegat er undersøgt et mindre Materiale af Efteraarssild, der er fanget i Snurpenot.

Samtidig med Indsamlingerne af Sild er der i de fleste Tilfælde taget et Træk i Vandet med en mindre Planktonpose for derved at faa et Indtryk af Planktonets Sammensætning paa vedkommende Sted. Der er ialt indsamlet ca. 250 Planktonprøver, hvorved det for forskellige Organismers Vedkommende har været muligt at foretage en Sammenligning mellem deres Forekomst i Sildeføden og i Planktonet.

De mere regelmæssige Indsamlinger af Bundgarnssild og Plankton er udført af følgende: Fisker Hans Poulsen, Rudkøbing, Fiskeribetjent H. Konradsen, København, Fiskerifoged Fr. Petersen, Samsø og Fisker Søren Bjerregaard, Frederikshavn. Jeg benytter Lejligheden til at takke disse for den Omhu, hvormed de har indsamlet det store Materiale, der danner det væsentligste Grundlag for nærværende Arbejde. Ligeledes takker jeg Føreren af Havundersøgelsesdamperen »Dana«, Kaptajn G. Hansen, der med stor Beredvillighed og Interesse har assisteret mig ved Udførelsen af en Række forskellige Forsøg.

De vigtigste Resultater i Afhandlingen kan sammenfattes i nedenstaaende Punkter:

1. **Den relative Mængde af Sild med Føde i Fordøjelseskanalen** er meget forskellig inden for de forskellige Stadier i Sildens Udvikling fra Larve og til voksen Fisk. Hos Sildeunger, hvor Blommesækken endnu er til Stede, finder man undertiden Føde i Fordøjelseskanalen, men de foreliggende Undersøgelser tyder paa, at det kun er mere undtagelsesvis, at de ganske spæde Sildelarver tager Føde til sig. De yngste Individer af postlarvale Sild optager tilsyneladende ogsaa kun Næring i ringe Grad, men naar de har opnaaet en Længde paa ca. 20 mm., er der konstateret Føde hos mindst 50 % af de undersøgte Eksemplarer. Procentmængden af Postlarver med Føde vokser med Dyrenes tiltagende Størrelse, og naar disse indtræder i Metamorfose-Stadiet, hvor Skældannelsen paabegyndes (Længde ca. 38—40 mm.), finder man som Regel Føde hos alle Individer. For Ungsild gælder det, at de næsten altid har Føde i Mavesækken. Gennemsnitlig er der saaledes konstateret Føde hos 95.5 % af de undersøgte Ungsild, og Procentmængden er høj for Ungsild ikke alene fra forskellige Farvande, men ogsaa fra forskellige Tider paa Aaret. Den relative Mængde af voksne Sild med Føde er gennemgaaende betydelig mindre end for Ungsilds Vedkommende. Af samtlige voksne Sild er der saaledes kun fundet Føde i Maven hos lidt over Halvdelen (57.2 %). Den gennemsnitlige Procentmængde for de fire Lokaliteter med Bundgarnssild er saaledes: Rudkøbing 50.8, Sundet og Køge Bugt 70.1, Samsø 65.8 og Frederikshavn 42.3.

Der synes ikke for Silden i de indre danske Farvande at være bestemte Aarstider, hvor Fødeoptagelsen er særlig stor og andre, hvor den er ringe, saaledes som det er paavist for Silden langs Vestkysten af Skotland og i Nordsøen. (Brook & Calderwood 1886, p. 103, Hardy 1924, p. 15).

2. **Føde hos larvale Sild (Blommesæk til Stede).** Føde er kun paavist i Fordøjelseskanalen hos enkelte spæde Sildeunger fra Foraaret, og Føden bestod i de foreliggende Tilfælde af et ubestemmeligt Stof af svag grønlig Farve (formodentlig Flagellater o. lign.).

3. **Føde hos postlarvale Sild (Blommesæk resorberet).** De yngste Stadier af postlarvale Sild lever i overvejende Grad af Phytoplankton (især Diatoméer og Peridinéer). Indenfor forskellige Størrelser af Postlarver er der om Foraaret fundet følgende relative Mængder med Phytoplankton som Føde: Lgd. 5—6 mm. 100 %, Lgd. 7—11 mm. 25—50 % og 12—17 mm. mindre end 25 %. Naar Postlarverne har opnaaet en Længde af ca. 17 mm., lever de udelukkende af animalske Planktonorganismer. De yngre Postlarver optager foruden Phytoplankton især Copepodæg, Nauplier og unge Stadier af Copepoder som Næring. Voksne Copepoder er tidligst paavist som Føde hos Postlarver af 10 mm. Lgd. I Postlarver af en Længde paa 13—14 mm. er voksne Copepoder fundet nogenlunde almindeligt som Føde, og for ældre postlarvale Sild er de langt de vigtigste Fødeorganismer. De forskellige Copepoder er truffet som Føde hos følgende Minimumslængder af Postlarver: *Pseudocalanus elongatus* & *Paracalanus parvus* 10 mm., *Acartia sp.* & *Oithona sp.* 12 mm., *Temora longicornis* 18 mm. og *Centropages hamatus* 26 mm. De to førstnævnte Arter har især Betydning som Føde for postlarvale Sild om Foraaret. Hos Postlarver fra Efteraaret (Lgd. 10—15 mm.) er der, foruden Phytoplankton og Copepoder, paavist enkelte Cladocerer og Muslingelarver som Føde.

4. **Føde hos Metamorfose-Stadier (Skældannelse begyndt).** Naar Silden har opnaaet en Længde paa 35—40 mm., bliver Føden mere forskelligartet, men Copepoderne udgør dog langt den vigtigste Næring. Hos det foreliggende Materiale af Metamorfose-Stadier, der omtrent udelukkende stammer fra Skagerrak, er *Temora longicornis* fundet som den hyppigste Copepod. Copepodæg og Nauplier (formentlig af *Calanus finmarchicus*) er truffet i mindre Antal, medens Cladocerer, Cirripedlarver, Polychætlarver og Muslingelarver ret ofte er konstateret som Bestanddele af Føden.

5. **Føde hos Ungsild.** Copepoderne er i kvantitativ Henseende dominerende i Føden hos Ungsild, men om Sommeren og Efteraaret har Cladocerer desuden en ret stor Betydning. Paa enkelte Steder er Gastropodlarver og Decapodlarver paavist i betydeligt Antal som Føde for Ungsild om Efteraaret, og paa denne Aarstid er endvidere ofte truffet Polychæter, Chætognather og Appendicularier som vigtige Fødeorganismer. Hos Ungsild fra Læsø Rende er Diatoméer (*Coscinodiscus*) fundet i ret stor Mængde i August Maaned, men Phytoplankton har sikkert i Almindelighed kun en underordnet Betydning som Næring for disse Størrelser af Sild. I Nordsøen (Graadyb) lever Ungsild om Vinteren i overvejende Grad af Copepoder (især *Temora longicornis* og *Pseudocalanus elongatus*), men tager desuden især en Del Mysider, Amphipoder og Cumacéer.

6. **Føde hos voksne Sild.** Føden hos voksne Sild har en meget forskelligartet Sammensætning. Den bestaar i overvejende Grad af forskellige Krebsdyr, men desuden af en Række andre Organismer. Af samtlige undersøgte voksne Sild med Maveindhold er Krebsdyr fundet som Føde hos ca. 93 % og andre Organismer hos ca. 32 %.

De vigtigste Krebsdyr i Sildeføden er: Copepoder, Cladocerer, Mysider, Amphipoder og Isopoder, medens Cumacéer, Decapodlarver og Cirripedlarver er fundet mindre hyppigt. Ostracoder er kun konstateret ganske undtagelsesvis. Af Fødeorganismer udenfor Krebsdyrene maa især fremhæves Fiskeæg, Polychæter og Gastropodlarver. Mindre Fisk og Fiskeunger, Chætognather og Appendicularier er desuden fundet ret almindeligt, medens Muslingelarver og Bryozolarver kun er paavist i yderst faa Tilfælde.

I kvantitativ Henseende er Copepoderne de vigtigste Fødeorganismer for Silden i danske Farvande. Særlig stor Betydning har Arterne *Pseudocalanus elongatus*, *Temora longicornis* og *Centropages hamatus* samt for et enkelt Farvand (Sundet og Køge Bugt) Slægten *Acartia*. Af Cladocerer er Slægterne *Evadne* og *Podon* fundet hyppigst, men Arten *Bosmina maritima* er enkelte Gange paavist i stor Mængde i Maveindholdet hos Sild fra Sundet og Køge Bugt. Af Mysider er *Gastrosaccus spinifer* og *Schistomysis spiritus* konstateret i stort Antal, og af Amphipoder er *Gammarus locusta* absolut dominerende i Mængde. Isopoderne er næsten udelukkende repræsenteret ved Slægten *Idothea*, og Cumacéerne især ved Slægten *Diastylis*. Af Decapoder er der med faa Undtagelser kun fundet Larvestadier i Sildeføden, især Krabbelarver og larvale Stadier af Hestereje (*Crangon*). Saavel Nauplier som Cyprisstadier af Cirripedier er truffet, de sidstnævnte hyppigst.

Af Fødeorganismer udenfor Krebsdyrene er der især Anledning til at nævne, at Sildeæg er fundet i betydeligt Antal i Sildemaverne paa de Tider af Aaret, hvor Sildens Gydning finder Sted. Det har ikke været muligt at bestemme de i Sildeføden fundne Mollusklarver. Det samme gælder for en stor Del af de i Maveindholdet paaviste Polychæter, men Slægten *Nereis* er dog utvivlsomt særlig stærkt repræsenteret. Unge Eksemplarer af Slægterne *Ammodytes* og *Clupea* er de vigtigste Fisk, der tjener som Næring for Silden. Larvale og postlarvale Sild er særlig enkelte Steder fundet i stort Antal i Sildenes Maveindhold. Af Chætognather er paavist Slægten *Sagitta* og af Appendicularier udelukkende Slægten *Oikopleura*.

7. **Fødens Sammensætning i forskellige Farvande.** Paa de fire Steder, hvor der er foretaget mere regelmæssige Undersøgelser over Føden hos voksne Sild, nemlig Rudkøbing, Sundet, Samsø og Frederikshavn, er der en Del Forskelligheder i Fødens Sammensætning. Der er især Anledning til at fremhæve følgende Forhold:

Af Copepoder har Slægten *Acartia* en forholdsvis langt større Betydning som Næring for Silden i Sundet end for Sild i de øvrige Farvande, hvor der er foretaget Undersøgelser. Forskellige Arter som f. Eks. *Calanus finmarchicus, Centropages typicus* og *Labidocera Wollastoni* forekommer om Sommeren og Efteraaret i relativt større Antal i Føden hos Sild fra Frederikshavn end sydligere i vore Farvande.

Af Cladocerer er Slægterne *Evadne* og *Podon* paavist som Føde hos Sild fra alle fire Lokaliteter. Slægten *Bosmina* er derimod udelukkende truffet i Maveindholdet hos Sild fra Sundet og Køge Bugt.

Mysider er fundet i størst Antal hos Sild fra Rudkøbing, i mindre Mængde hos Sild fra Sundet og Samsø og i yderst ringe Antal hos Sild fra Frederikshavn.

Isopoder er ligeledes paavist i forholdsvis størst Mængde i Sildeføden i de sydligere Farvande (Rudkøbing og Sundet).

Cumacéer har i overvejende Grad Betydning som Sildeføde i Farvandet ved Rudkøbing.

I ingen af de undersøgte Sild fra Sundet og Køge Bugt er der konstateret Polychæter som Føde, medens disse er truffet ret almindeligt som Næring for Sild fra Rudkøbing, Samsø og Frederikshavn.

Larvale Stadier af Gastropoder er fundet i relativ størst Mængde som Næring for Sild om Efteraaret fra Samsø og Frederikshavn.

Fiskeæg er kun paavist i yderst ringe Antal som Føde for Sild ved Frederikshavn om Efteraaret. I de andre Farvande er Fiskeæg, særlig Sildeæg, derimod fundet i ret betydelig Mængde i Sildeføden paa denne Aarstid.

8. **Fødens Sammensætning paa forskellige Tider af Aaret.** De Organismer, der dominerer i Antal i Sildeføden paa de forskellige Tider af Aaret, er noget varierende paa de forskellige Steder, hvor der er foretaget Undersøgelser, men følgende Forhold maa i store Træk siges at være gældende for voksne Sild i de indre danske Farvande: Om Vinteren og især om Foraaret bestaar Føden i langt overvejende Grad af Copepoder, medens disse har en forholdsvis ringe Betydning som Fødeemne om Sommeren og Efteraaret. Hen paa Sommeren aftager de saaledes som Regel i Antal i Sildemaverne, og i Efteraarsmaanederne findes Copepoder ofte kun i ringe Mængde. En Del andre Organismer forekommer derimod i størst Mængde om Sommeren og Efteraaret. Cladocerer og Polychæter har saaledes deres maximale Forekomst i Sildeføden om Sommeren (Maj—August) og Decapodlarver i Eftersommeren (Juli—September). Mysider, Isopoder, Amphipoder og Fisk har langt den største Betydning som Føde for Silden i den sidste Halvdel af Aaret (Juli—December), og Cumacéer, Gastropodlarver, Chætognather og Appendicularier findes saa godt som udelukkende i Sildeføden om Efteraaret (August—November). Fiskeæg er paavist som Føde i de fleste af Aarets Maaneder, men da en meget stor Del af Æggene er Sildeæg, er de største Antal fundet om Foraaret og Efteraaret, svarende til de vigtigste Tidspunkter for Sildens Gydning.

9. **Fødeoptagelsen i Relation til Sildens Modenhedsgrad.** Det fremgaar af de foreliggende Undersøgelser, at Sildens Fødeoptagelse som Regel er forholdsvis ringe under Gydningen og umiddelbart før denne, men man kan dog undertiden finde ret betydelige Fødemængder i Maven hos gydefærdige Sild. Dette gælder i Særdeleshed for den foraarsgydende og efteraarsgydende Sild fra Farvandet ved Rudkøbing og Samsø. Hos gydefærdige Efteraarssild fra det nordøstlige Kattegat (Groves Flak) er der derimod kun fundet Føde hos meget faa Sild og i de foreliggende Tilfælde kun i yderst ringe Mængde. Den modne foraarsgydende Sild fra Rudkøbing og Samsø synes imidlertid i langt højere Grad at tage Føde til sig end den modne efteraarsgydende Sild fra begge disse Lokaliteter. Den relative Mængde af kønsmodne Sild med Føde fra Rudkøbing og Samsø er om Foraaret henholdsvis 62.0 % og 73.1 % og om Efteraaret henholdsvis 20.6 % og 43.1 %. Ved Analyse af Maveindholdet hos gydende Sild er der undertiden fundet betydelige Mængder af Føde. Hos en enkelt Sild er saaledes optalt ca. 600 Copepoder, hos en anden 190 Sildeæg og 25 Copepoder, hos en tredje 280 Sildelarver og enkelte Copepoder etc.

10. **Sammenligning mellem Føden hos Ungsild og hos voksne Sild.** Da der foreligger nogle faa Prøver af Ungsild og voksne Sild, der er indsamlet paa samme Sted og Tid, er der Anledning til at fore-

tage en Sammenligning mellem Føden hos disse. Den relative Mængde af Ungsild med Føde er som nævnt overalt langt større end den relative Mængde af voksne Sild med Føde. De respektive Tal for Sild fra Frederikshavn i Oktober 1923 er saaledes 95.7 % og 50.0 %. Det gennemsnitlige Antal af de forskellige Organismer pr. Sild er da ogsaa som Regel langt større for Ungsild end for voksne Sild. Dette gælder i særlig Grad for Copepoder, men Cladocerer, Cirripedlarver, Gastropodlarver og Appendicularier synes ligeledes at efterstræbes i højere Grad af Ungsild end af voksne Sild. Fisk og Fiskeæg er derimod gennemgaaende fundet i større Antal hos voksne Sild end hos Ungsild. Det er paavist for Sild fra Frederikshavn, at Gastropodlarver om Efteraaret udgør en meget vigtig Næring for Ungsild (Lgd. 12—15 cm.) samt for de mindste Størrelser af voksne Sild (Lgd. 17—18 cm.), medens de ikke er paavist i Maveindholdet hos Sild af større Længde.

11. **Fødeoptagelsen paa forskellige Tider af Døgnet.** I Graadyb er der foretaget en Række Undersøgelser over Fødeoptagelsen hos Ungsild paa forskellige Tider af Døgnet, idet der er udført Analyser af Maveindholdet hos Sild, der er fanget paa forskellige Tider Døgnet rundt. Resultatet af disse Forsøg viser, at Ungsild i væsentlig Grad tager Føde til sig om Dagen, og at Fødeoptagelsen om Natten i hvert Fald er relativt ringe. De nævnte Undersøgelser er alene foretaget i Vinterhalvaaret.

12. **Sildeføden i Relation til Planktonets Sammensætning.** Da en meget stor Del af de Organismer, der tjener som Føde for Silden, enten slet ikke eller kun i meget ringe Grad er indfanget ved Træk med de anvendte Planktonposer, er det kun muligt for et mindre Antal Organismers Vedkommende at foretage en Sammenligning mellem disses Forekomst i Sildeføden og i de indsamlede Planktonprøver. Følgende Grupper af Organismer, der ofte har stor Betydning som Næring for Silden, er saaledes taget i saa ringe Antal ved Planktontrækkene, at man ikke faar noget virkeligt Udtryk for den Mængde, hvori de findes i Vandet: Mysider, Cumacéer, Isopoder, Amphipoder, Polychæter og tildels Fisk og Fiskeæg (spec. Sildeæg). De foreliggende Planktonprøver er imidlertid tilstrækkelige til at vise, at Silden ikke optager alle de i Planktonet forekommende Organismer som Næring, men at den udvælger visse Organismer fremfor andre. Coelenterater og Echinodermlarver er saaledes aldrig paavist i Sildeføden, og Phytoplankton (Diatoméer) er kun ganske undtagelsesvis fundet i større Mængde i Maveindholdet hos voksne Fisk. Forskellige Organismer, der til Tider træffes talrigt i Planktonet, som f. Eks. Bryozolarver, Muslingelarver, Chætognather og Appendicularier, er som Regel kun fundet i sparsom Mængde som Bestanddele af Sildeføden. Smaa Former af Copepoder, som f. Eks. Slægten *Oithona*, er ligeledes kun truffet i yderst ringe Antal i Sildemaverne, selv om de er konstateret i stor Mængde i Planktonet. I andre Tilfælde er der derimod paavist en ret god Overensstemmelse mellem Organismernes mere eller mindre talrige Forekomst i Sildenes Maveindhold og i Planktonet. Dette gælder især for de fleste Copepoders og Cladocerers Vedkommende.

Som det fremgaar af det foregaaende, maa Copepoderne, i hvert Fald om Foraaret og Vinteren, betragtes som de vigtigste Fødeorganismer for Silden i danske Farvande. En Undersøgelse af den foreliggende Litteratur viser, at Silden ogsaa i andre Havomraader i høj Grad efterstræber Copepoder som Føde, men at andre Organismer desuden har stor Betydning som Sildeføde. I den sydvestlige Del af Nordsøen, hvor der er foretaget særlig omfattende Undersøgelser, lever den voksne Sild saaledes om Foraaret i langt overvejende Grad af unge Tobis (*Ammodytes*), hvad der er ganske afvigende fra Forholdet i de indre danske Farvande. Om Sommeren bestaar Føden i Nordsøen derimod fortrinsvis af Copepoder, Amphipoder og forskellige andre Organismer. I Østersøen og den botniske Bugt spiller, foruden Copepoder, især Mysider en Rolle som Sildeføde. I Skagerrak, langs Vestkysten af Skotland og Irland, i det irske Hav og i Kanalen er Copepoder og Euphausider af særlig stor Betydning som Føde, og de samme Organismer anføres som den vigtigste Sildeføde langs de atlantiske Kyster af Nordamerika. Ved Norges Kyster lever Silden ligeledes især af Copepoder, men andre Organismer, som Pteropoder, Cladocerer, osv., har ogsaa stor Betydning, og i Farvandene omkring Island udgør Copepoder, Krabbelarver og unge Tobis den vigtigste Sildeføde.

Om Sildens Føde i danske Farvande kan i store Træk siges følgende: Larvale Stadier af Sild lever formentlig af ganske smaa Protister, som paa Grund af Nøgenhed og Lidenhed ikke nærmere kan undersøges. De yngste Postlarver lever fortrinsvis af større Phytoplankton (Diatoméer og Peridinéer), men optager desuden ret snart mindre animalske Organismer som Føde, især Copepodæg, Nauplier og unge Stadier af Copepoder. Phytoplankton har kun Betydning som Næring for de yngre Postlarver. Zooplanktonet dominerer i Føden saavel hos de ældre Stadier af disse, som i Føden hos alle senere Udviklingstrin af Silden. Copepoderne har særlig Betydning som Fødeorganismer, men Ungsild og især voksne Sild søger desuden mange andre Organismer som Føde (Cladocerer, Amphipoder, Decapodlarver, Fiskeæg, Mysider o. s. v.). Der er Forskel i Fødens Sammensætning ikke alene efter Sildens Alder, men ogsaa efter forskellige Farvande og efter forskellige Aarstider.

CONTENTS

Page

Introduction ... 3
I. Survey of the Most Important Works Dealing with the Food Biology of the Herring ... 4
II. Methods of Collecting and Treatment of the Material ... 7
III. Results of Investigations into the Food of the Herring in various Danish Waters ... 11
A. Larval, Post-larval and Metamorphosis Stages of Herring ... 11
1. The food of the larval stages (yolk sac still present) ... 12
2. The food of post-larval and metamorphosis stages ... 12
3. Concluding remarks on the food of larval, post-larval and metamorphosis stages of herring 17
B. Adult Herring and Young Herring ... 18
1. Rudkøbing ... 18
a. Material ... 18
b. The relative numbers of herring containing food in the different months ... 20
c. Brief survey of the composition of the food ... 21
d. Systematic survey of the occurrence of the different organisms in the food ... 24
e. Concluding remarks on the food of the herring in Rudkøbing waters ... 44
2. The Sound and Køge Bugt ... 45
a. Material ... 45
b. The relative numbers of herring containing food in the different months ... 45
c. Brief survey of the composition of the food ... 46
d. Systematic survey of the occurrence of the different organisms in the food ... 47
e. Concluding remarks on the food of the herring in the Sound and Køge Bugt ... 62
3. Samsø ... 62
a. Material ... 62
b. The relative numbers of herring containing food in the different samples ... 64
c. Brief survey of the composition of the food ... 64
d. Systematic survey of the occurrence of the different organisms in the food ... 65
e. Concluding remarks on the food of the herring in Samsø waters ... 81
4. Frederikshavn and Læsø Rende ... 81
a. Material ... 81
b. The relative numbers of herring containing food in the different months ... 82
c. Brief survey of the composition of the food ... 82
d. Systematic survey of the occurrence of the different organisms in the food ... 85
e. Concluding remarks on the food of the herring from Frederikshavn and Læsø Rende . 93
5. Groves Flak, Kattegat ... 93
6. The North Sea. Stations along the West Coast of Jutland ... 95
7. The North Sea. Graadyb ... 97
a. Material ... 97
b. The relative numbers of herring containing food in the different months ... 98
c. Brief survey of the composition of the food ... 98
d. Systematic survey of the occurrence of the different organisms in the food ... 99
e. Concluding remarks on the food of the herring from Graadyb ... 108
IV. Various Observations on the Food Biology of the Herring in Danish Waters ... 109
1. Number of herring containing food in relation to age ... 109
2. Feeding in relation to development of genital organs ... 111
3. Food of the adult herring in different waters and at different seasons ... 113
4. Food of young herring compared with that of adults ... 126
5. Investigations as to feeding at different times of the day and night ... 128
V. Principal Organisms in the Food of the Herring in Danish Waters and elsewhere ... 132
VI. Summary of Principal Results ... 134
Tables of Stomach Analyses ... 136
List of Literature ... 141
Dansk Resumé ... 144

Bd. V, Nr. 2 A. C. Strubberg: Marking Experiments with cod at the Færoes. 24 Fig. 1916. 126 p. Kr. 4.00.

» V, » 3 A. C. Johansen: Marking Experiments with Sole (Solea vulgaris Quensel) and Turbot (Rhombus maximus L.) in the Kattegat and Baltic Waters: 4 Fig. 1916. 18 p. Kr. 0.50.

» V, » 4 Johs. Schmidt: On the early larval stages of the Fresh-Water Eels (Anguilla) and some other North Atlantic Murænoids. 4 Plates and 14 Fig. 1916. 20 p. Kr. 1.75.

» V, » 5 P. Jespersen: Contributions to the Life-History of the North Atlantic Halibut (Hippoglossus vulgaris Flem.) 1 Plate and 16 Fig. 1917. 32 p. Kr. 1.50.

» V, » 6 A. C. Strubberg: Marking Experiments with Plaice and Lemon Soles at the Færoes in 1910—12. 28 Fig. 1918. 64 p. Kr. 2.25.

» V, » 7 Johs. Schmidt: Stations in the Atlantic, etc. 1911—15. With two Charts and introductory remarks. 1919. 27 p. Kr. 1.50.

» V, » 8 A. C. Johansen: On the large spring-spawning Sea Herring (Clupea harengus L.) in the north-west European waters. 14 Fig. 1919. 56 p. Kr. 1.75.

» V, » 9 A. C. Johansen and Kirstine Smith: Investigations as to the effect of the restriction on fishing during the war on the plaice of the eastern North Sea. 10 Fig. 1919. 53 p. Kr. 1.75.

» VI, » 1 P. Jespersen: On the occurrence of the post-larval stages of the Herring and the »Lodde« (Clupea harengus L., and Mallotus villosus O. F. M.) at Iceland and the Færoes. 1920. 10 Fig. 24 p. Kr. 1.25.

» VI, » 2 Kirstine Smith: Danish Investigations of Plaice from the North Sea July 1919—July 1920. 1921. 2 Fig. 68 p. Kr. 4.75.

» VI, » 3 A. C. Johansen: On the Summer-spawning Herring (Clupea harengus L.) of Iceland. 1921. 4 Fig. 40 p.

» VI, » 4 A. C. Johansen: The Atlanto-Scandian Spring Herring spawning at the Faroes 1921. 11 p. Kr. 3.75.

» VI, » 5 J. P. Jacobsen and A. C. Johansen: On the Causes of the Fluctuations in the Yield of some of our Fisheries.
I. The Salmon and Sea Trout Fisheries. 1921. 11 Fig. 18 Tab. 48 p. Kr. 3.50.

» VI, » 6 Johs. Schmidt: Contributions to the Knowledge of the Young of the Sun-Fishes (*Mola* and *Ranzania*). 1921. 1 Pl. 15 Fig. 13 p. Kr. 1.50.

» VI, » 7 Erik M. Poulsen: On the Frequency and Distribution of *Crangon vulgaris, Carcinus mœnas* and *Portunus holsatus* in the Danish coastal waters. 1922. 4 Fig. 2 Tab. 18 p. Kr. 1.65.

» VI, » 8 A. C. Johansen: On the Density of the Young Plaice Population in the eastern part of the North Sea and the Skagerak in pre war and in post war years. 1922. 10 Fig. 10 Tab. 31 p. Kr. 2.50.

» VI, » 9 J. P. Jacobsen and A. C. Johansen: On the Causes of the Fluctuations in the Yield of some of our Fisheries.
II. The Eel Fisheries. 1922. 20 Fig. 6 Tab. 32 p. Kr. 2.75.

» VII, » 1 A. C. Strubberg: Marking Experiments with Cod (Gadus callarias L.) in Danish Waters, 1905—1913. 1922. 17 Fig. 27 Tab. 60 p. Kr. 4.25.

» VII, » 2 Kirstine Smith: Investigations of Plaice from the Western Baltic June 1921—August 1922. 1923. 6 Fig. 14 Tab. 48 p. Kr. 3.50.

» VII, » 3 Bjarni Sæmundsson: On the Age and Growth of the Cod (Gadus callarias L.) in Icelandic Waters. 1923. 8 Fig. 35 p. Kr. 2.75.

Bd. VII, Nr. 4 Kirstine Smith: On the Plaice Population of the Horns Reef Area in the Autumn of 1922. 1923. 14 Fig. 78 p. Kr. 5.50.

» VII, » 5 A. C. Johansen: On the Summer- and Autumn-Spawning Herrings of the North Sea. 1924. 15 Fig. 119 p. Kr. 8.00.

» VII, » 6 P. L. Kramp: Fish eggs and larvæ collected in the Belt Sea in March 1922. 1924. 4 Fig. 19 p. Kr. 1.75.

» VII, » 7 Ad. S. Jensen: On the Fishery of the Greenlanders. 1925. 31 Fig. 1 Chart. 38 p. Kr. 3.00.

» VII, » 8 A. C. Johansen: On the Influence of the Currents upon the Frequency of the Mackerel in the Kattegat and adjacent parts of the Skagerak. 1925. 15 Fig. 26 p. Kr. 2.25.

» VIII, » 1 Bjarni Sæmundsson: On the age and growth of the Haddock (Gadus æglefinus L.) and the Whiting (Gadus merlangus L.) in Icelandic waters. 1925. 8 Fig. 33 p. Kr. 2.65.

» VIII, » 2 A. C. Johansen: On the diurnal vertical Movements of Young of some Fishes in Danish Waters. 1925. 11 Fig. 28 p. Kr. 2.25.

» VIII, » 3 Martin Knudsen: A Bottom Sampler for hard Bottom. 1927. 2 Fig. 4 p.

» VIII, » 4 A. C. Johansen: Preliminary Experiments with Knudsen's Bottom Sampler for hard Bottom. 1927. 3 Tab. 6 p. Kr. 1.25.

» VIII, » 5 Anton Fr. Bruun: Quantitative investigations of the 0-group and I-group of the Plaice, Turbot, Brill and Sole in the Skagerrak, Kattegat and Belt Sea. 1927. 6 Fig. 11 Tab. 6 Charts. 30 p. Kr. 2.50.

Serie: Hydrografi.

Bd. I, Nr. 1 Martin Knudsen: On the organisation of the Danish hydrographic researches. 1904. 7 p.

» I, » 2 H. J. Hansen: Experimental determination of the relation between the freezing point of sea-water and its specific gravity at 0° C. 1904. 10 p.

» I, » 3 N. Bjerrum: On the determination of Chlorine in sea-water and examination of the accuracy with which Knudsen's pipette measures a volume of sea-water. 1904. 11 p. Kr. 1.25.

» I, » 4 J. N. Nielsen: Hydrography of the waters by the Faroe Islands and Iceland during the cruises of the Danish research steamer "Thor" in the summer 1903. 8 Plates. 1904. 29 p.

» I, » 5 Niels Bjerrum: On the determination of Oxygen in sea-water. 1904. 13 p. Kr. 3.50.

» I, » 6 Martin Knudsen: Contribution to the Hydrography of the North Atlantic Ocean. 21 Plates. 13 p. Kr. 5.75.

» I, » 7 J. N. Nielsen: Contributions to the Hydrography of the waters north of Iceland. 2 Plates 28 p.

» I, » 8 J. P. Jacobsen: Die Löslichkeit von Sauerstoff im Meerwasser durch Winklers Titriermethode bestimmt. 1905. 13 S. Kr. 2.00.

» I, » 9 J. N. Nielsen: Contribution to the Hydrography of the north-eastern part of the Atlantic Ocean. 3 Plates. 1907. 25 p. Kr. 1.75.

» I, » 10 J. P. Jacobsen: Mittelwerte von Temperatur und Salzgehalt. Bearbeitet nach hydrographischen Beobachtungen in dänischen Gewässern 1880—1907. 11 Tafeln. 1908. 28 S. Kr. 3.50.

» I, » 11 J. N. Nielsen: Contribution to the understanding of the currents in the northern part of the Atlantic Ocean. 1 Plate. 1908. 15 p. Kr. 0.75.

» I, » 12 J. P. Jacobsen: Der Sauerstoffgehalt des Meereswassers in den dänischen Gewässern innerhalb Skagens. 5 Tafeln. 1908. 23 S. Kr. 2.00.

» I, » 13 Kirstine Smith: Gezeitenstroeme bei den Feuerschiffen Vyl und Horns Rev. Mit 4 Textfiguren. 1910. 23 S. Kr. 0.75.

Bd. I, Nr. 14 J. P. JACOBSEN: Gezeitenstroeme und resultierende Stroeme im Grossen Belt in verschiedenen Tiefen im Monat Juni 1909. Mit 7 Figuren im Text. 1910. 19 S. Kr. 0.75.

» II, » 1 MARTIN KNUDSEN: Danish hydrographical investigations at the Faroe Islands in the spring of 1910. 2 Plates. 1911. 17 p. Kr. 1.00.

» II, » 2 J. P. JACOBSEN: Beitrag zur Hydrographie der dänischen Gewässer. 47 Tabellen, 17 Textfiguren, 14 Tafeln. 1913. 94 S. Kr. 6.50.

» II, » 3 J. P. JACOBSEN: Strommessungen in der Tiefe in dänischen Gewässern in den Jahren 1909—1910 und 1911. Mittlere Werte des Stroms und Konstanten der Gezeitenbewegung. 1913. 43 S. Kr. 1.25.

» II, » 4 J. P. JACOBSEN: Hydrographical investigations in Faeroe Waters in 1913. 15 Fig. 1915. 47 p. Kr. 1.50.

» II, » 5 J. P. JACOBSEN: Contribution to the Hydrography of the Atlantic. 7 Fig. 8 diagrams. 1916. 24 p. Kr. 0.75.

» II, » 6 TH. P. FUNDER: Hydrographic investigations from the Danish School Ship "Viking" in the Southern Atlantic and Pacific in 1913—14. 1916. 28 p. Kr. 1.00.

» II, » 7 J. P. JACOBSEN: Hydrographische Untersuchungen im Randers Fjord (Jylland). 1918. 46 S. Kr. 2.50.

» II, » 8 Current Measurements from Danish Lightships. 1923. 78 p. Kr. 5.50.

» II, » 9 J. P. JACOBSEN: Die Wasserumsetzung durch den Öresund, den grossen und den kleinen Belt. 1925. 20+VII Tab. 72 S. Kr. 5.00.

Serie: Plankton.

Bd. I, Nr. 1 OVE PAULSEN: Plankton-Investigations in the waters round Iceland in 1903. 2 Maps. 1904. 41 p.

» I, » 2 C. H. OSTENFELD: On two new marine species of Heliozoa occurring in the Plankton of the North Sea and the Skager Rak. 1904. 5 p. Kr. 2.00.

Bd. I, Nr. 3 OVE PAULSEN: On some Peridineæ and Plankton-Diatoms. 1905. 7 p. Kr. 0.25.

» I, » 4 OVE PAULSEN: Studies on the biology of Calanus finmarchicus in the waters round Iceland. 3 Plates. 1906. 21 p. Kr. 1.75.

» I, » 5 OVE PAULSEN: The Peridiniales of the Danish Waters 1907. 26 p. Kr. 0.75.

» I, » 6 C. H. OSTENFELD: On the immigration of Biddulphia sinensis Grev. and its occurrence in the North Sea during 1903—07 and on its use for the study of the direction and rate of flow of the currents. 4 Charts and 5 Text-Figures. 1908. 44 p. Kr. 2.50.

» I, » 7 AUG. BRINKMANN: Vorkommen und Verbreitung einer Planktonturbellarie *Alaurina composita* Mecz. in dänischen Gewässern. 12 Figuren und 1 Karte. 1909. 15 S. Kr. 0.50.

» I, » 8 OVE PAULSEN: Plankton investigations in the waters round Iceland and in the North Atlantic in 1904 9 Figures. 1909 57 p. Kr. 1.75.

» I, » 9 ANDREAS OTTERSTRØM: Beobachtungen über die senkrechten Wanderungen des Mysisbestandes in der Ostsee bei Bornholm in den Sommermonaten 1906 und 1907. 1 Fig. 1910. 10 S. Kr. 0.25.

» I, » 10 C. H. OSTENFELD: A revision of the marine species of Chætoceras Ehbg. Sect. Simplicia Ostf. With 24 Figures in the text. 11 p.

» I, » 11 J. P. JACOBSEN and OVE PAULSEN: A new apparatus for measuring the volume of plankton samples by displacement. 6 p. 1912. Kr. 0.50.

» I, » 12 P. L. KRAMP: Medusæ, Ctenophora and Chætognathi. From the Great Belt and the Kattegat in 1909. 1915. 20 p. Kr. 0.75.

» I, » 13 OVE PAULSEN: Plankton and other biological investigations in the Sea around the Færoes in 1913. 6 Figures 1918. 27 p. Kr. 2.00.

» II, » 1 GUSTAWA ADLER et P. JESPERSEN: Variations saisonnières chez quelques Copépodes planctoniques marins. 1920. 21 Figures. 39 Tab. 46 p. Kr. 3.00.

SKRIFTER UDGIVNE AF KOMMISSIONEN FOR HAVUNDERSØGELSER

Nr. 1 JOHS. SCHMIDT: Fiskeriundersøgelser ved Island og Færøerne i Sommeren 1903. 10 Tavler. 1904. VI + 148 S. Kr. 5.00. Udsolgt.

» 2 MARTIN KNUDSEN: Havets Naturlære. Hydrografi. Med særligt Hensyn til de danske Farvande. 10 Figurer, 4 Tavler. 1905. 41 S. Kr. 1.75. Udsolgt.

» 3 JOHAN HJORT og C. G. JOH. PETERSEN: Kort Oversigt over de internationale Fiskeriundersøgelsers Resultater med særligt Henblik paa norske og danske Forhold. 10 Tavler. 1905. 54 S. Kr. 3.50.

» 4 MARTIN KNUDSEN, C. G. JOH. PETERSEN, C. F. DRECHSEL, C. H. OSTENFELD: De internationale Havundersøgelser 1902—07. 1908. 28 S. Kr. 0.75.

» 5 BJARNI SÆMUNDSSON: Oversigt over Islands Fiske med Oplysning om deres Forekomst, vigtigste biologiske Forhold og økonomiske Betydning. 1 Kort. 1909. 140 S. Kr. 2.25.

Nr. 6 ANDREAS OTTERSTRØM: Sildens Afhængighed af forskellige hydrografiske og meteorologiske Forhold i Store Bælt. 2 Textfigurer. 1910. 52 S. Kr. 1.00.

» 7 A. C. JOHANSEN: Om Rødspætten og Rødspættefiskeriet i Beltfarvandet med nogle Bemærkninger om de øvrige Flynderarter og Flynderfiskerier i samme Farvand. 23 Tavler, 14 Textfigurer. 1912. 158 Sider. Kr. 3.00.

» 8 JOHS. SCHMIDT: Danske Undersøgelser i Atlanterhavet og Middelhavet over Ferskvandsaalens Biologi. 3 Tavler, 5 Textfigurer. 1912. 33 Sider. Kr. 1.50.

» 9 A. C. JOHANSEN og J. CHR. LØFTING: Om Fiskebestanden og Fiskeriet i Gudenaaens nedre Løb og Randers Fjord. — With an English Resumé. 4 Tavler. 42 Textfigurer. 1919. 169 Sider. Kr. 3.75.

» 10 ERIK M. POULSEN: Om Hummeren og Hummerfiskeriet i de danske Farvande. 6 Textfigurer. 1927. 42 Sider. Kr. 1.00.

The name: »Kommissionen for Havundersøgelser« has from the 1st of September 1926 been changed to: »Kommissionen for Danmarks Fiskeri- og Havundersøgelser«.